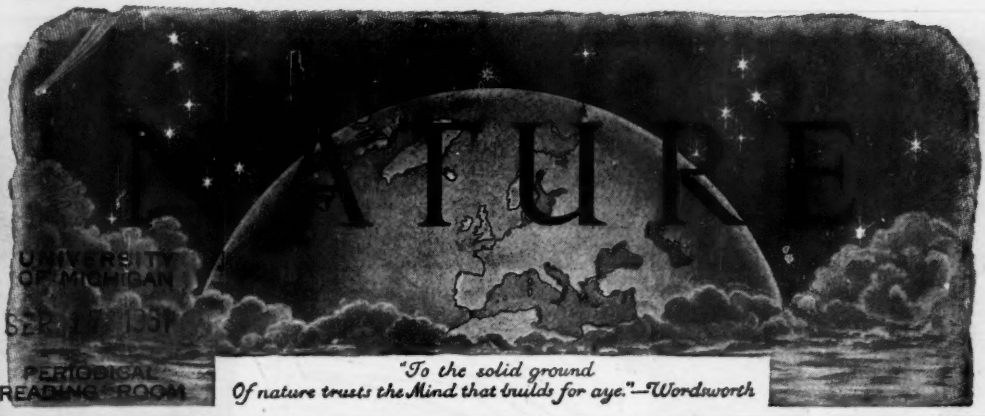
"NATURE", SEPTEMBER 1, 1951

SUPPLEMENT: INDEX TO VOLUME 167



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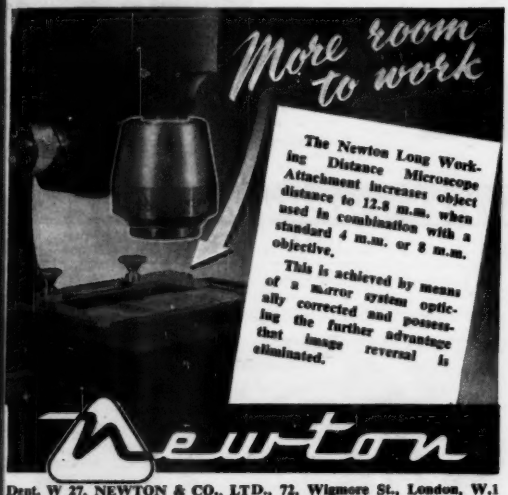
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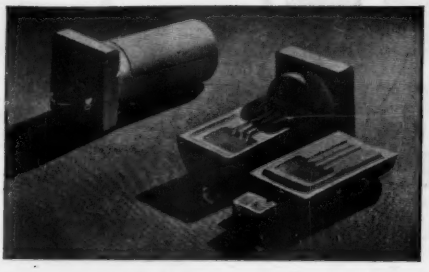

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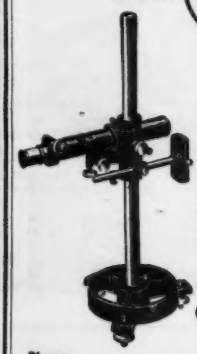

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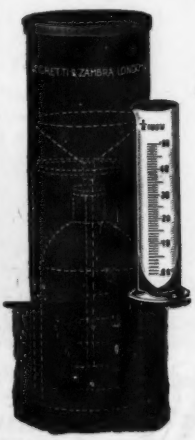

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VOLUNTARY BODIES AND THE SUPPORT OF RESEARCH

IN the admirable record of beneficent activity which characterizes the successive annual reports of the Nuffield Foundation, the discrimination and care with which the Foundation selects the projects for assistance is obvious. It can fairly be claimed that, over the six years of its activity, the Foundation has consistently fostered the growing-points of science, and especially of the biological and social sciences, in exactly the way that Lord Beveridge recognized as so important in his report on voluntary action. Much has, in fact, been done already by the Foundation to assist in keeping the advancing front of science in balance and ironing out the unevenness that sometimes hinders progress or contact between two or more fields.

One of the most interesting features of the Foundation's reports has always been the discussion of general policy and of the principles by which the trustees have sought to determine that policy. The sixth report* raises one matter of outstanding interest, especially to the scientific community, and its significance is strikingly emphasized by passages in two other recent reports from similar bodies—the Pilgrim Trust and the United Kingdom Carnegie Trust—as well as by one passage in the third report from the Committee of Public Accounts for the Session 1950–51.

The report welcomes the appointment last year by the Prime Minister of a committee under the chairmanship of Lord Nathan "to consider and report on the changes in the law and practice (except as regards taxation) relating to charitable trusts in England and Wales which would be necessary to enable the maximum benefit to the community to be derived from them"; it believes that it is in the public interest that the uses to which such funds can properly be put should be reviewed, and if necessary reformed. The report then emphasizes the need for flexibility rather than administrative convenience; while the ancient law of charities may require revision to meet modern needs, it is against too narrow and inelastic a definition of the objects of individual charitable bequests that precautions are required. Social advance would be impeded if charitable trusts were rigorously debarred from venturing into territories where statutory authorities are now enabled to make general social provision. As Lord Beveridge pointed out, new methods of meeting the changing needs of a developing society have in the past largely resulted from the prospecting of voluntary bodies, followed by central and local authorities consolidating and extending.

Any overlapping of effort or administrative untidiness is more than offset by the greater opportunity to experiment which such a relation between voluntary or private and public action affords, and the Nuffield Foundation rightly stresses the importance of such freedom to experiment, to move swiftly to the initiation or support of projects which promise to be of benefit to mankind. Some such projects might never be explored if it was always necessary to wait

* Nuffield Foundation. Report for the Year ending 31 March 1951. Pp. 113. (London: Nuffield Foundation, 1951.)

until public authority was convinced of the need, or could commit adequate resources to meet the need. The new feature in the situation to which the Foundation directs attention in this report is the possibility that bodies like itself may be faced with a less adventurous but more difficult choice of objectives. They may be required to turn from initiating to sustaining projects which hitherto have been sustained by the community.

The suggestion in the report that there may be a contraction of Government spending upon some social and intellectual purposes is not to be dismissed lightly. Though the nominal total of State support for learning and research has not as yet been decreased in the official estimates for the immediate future, the costs and materials of scholarship and research are steadily mounting in price. The real values of Government subvention, and of permanent endowments, for research are therefore bound to decrease. Moreover, the proposal in the White Paper on broadcasting policy to mulct the British Broadcasting Corporation of 15 per cent of the net revenue from wireless licences is not to be dismissed as merely an example of Treasury small-mindedness or dishonesty. If revenue contributed specifically for this purpose is to be raided thus as a contribution to rearmament, what is to stop the contributions of industry to the research associations or the revenue of the universities being raided on similar grounds ?

The speciousness of such an argument would be disturbing at any time, and in the present circumstances there will be profound disquiet in all circles interested in the furtherance of scientific and industrial research until the Government abandons so dubious a proposal. Nor is the disquiet diminished by the reference to the expenditure of the Department of Scientific and Industrial Research on the research associations contained in the report of the Select Committee on Public Accounts already noted. Commenting on the way in which the Industrial Grants Committee of the Advisory Council for Scientific and Industrial Research considers applications for grants and calculates the amount of any grant *pro rata* on the contribution made by the industry, the Select Committee expresses the opinion that *pro rata* grants are not best calculated to promote efficient economy, and may result in grants from public funds for research directly benefiting industries well able to meet the cost from their own resources.

The implications of this apparently reasonable argument deserve more attention than they have yet received. It is improbable that the Advisory Council, which is already informed of the details of research undertaken or proposed by each association, would be involved in any serious inquisition by the adoption of the Select Committee's recommendation for inquiry as to the financial position of the industry concerned. Leaving aside, however, the practical difficulty of assessing the capacity of an industry to finance research, the Committee's proposal for what is in effect a 'means test' shows a misconception of the whole purpose of co-operative research.

The case for State assistance of the research associations rests fundamentally on the belief that industrial research of this character is of direct advantage to the community as a whole, and not merely to the particular industry concerned. The economic well-being of the nation depends, in fact, on a progressive industry awake to all the opportunities which scientific and technical advance afford, and ready to turn them to advantage in the improvement of existing, or the development of new, products and processes. Part of the function of the research associations is indeed not so much the acquisition of new knowledge as the more effective and wider utilization of existing knowledge.

Accordingly, the important and fundamental question is not what should be the magnitude of any grant from the State, but whether the proposed programme of research is directed at the right targets. This is a question which is only with difficulty assessed from outside, and even from within an industry it may require a term of years to show the wisdom or otherwise of choosing the targets and activities adopted. Moreover, where part of the function of a research association is to educate the industry it serves and to seek to encourage the prosecution of research not only in the association's own laboratories but also in the industry at large, it would manifestly be a retrograde step to determine the research association's budget by the capacity of the industry to pay rather than, as at present, by the willingness of the industry to participate in co-operative research.

On the Select Committee's own showing, the Industrial Grants Committee of the Advisory Council is asking the right questions and putting first things first. Given that it is in the national interest to encourage as widely as possible the prosecution of industrial research, it would be a step backwards and false economy to change the emphasis or the arrangements and practice that have proved their value over more than three decades. What is essential is not the kind of scrutiny suggested by the Select Committee but, from time to time, a much more fundamental scrutiny of the whole structure and functioning of the research association movement in the light of changing conditions, to make sure that the nation and industry continue to get full value for their expenditure and that resources of money, materials and man-power are not diverted into this channel when they could more profitably be expended in other ways.

The outlook indicated in the Select Committee's report and in the Government's memorandum on the report of the Broadcasting Committee thus increases the concern already entertained, as suggested in the Nuffield Foundation's report, as to the possibility of rising costs compelling the Government to curtail scientific research. There has been no proposal as yet to cut the estimates for scientific research; but the situation fully warrants the suggestion that some statement of the Government's intentions should be made at an early date by the Lord President of the Council. Meanwhile, common prudence suggests that it would be wise for the Department of Scientific and Industrial Research, and also other bodies, including the universities, to scrutinize carefully their research

programmes and ancillary activities with the view of eliminating any items for which a convincing case cannot be argued, and making sure that there is no waste of either man-power or materials.

Whether or not the pessimism suggested by the Government's memorandum and the report of the Committee of Public Accounts is justified, a realistic approach to research budgeting is undoubtedly required. The Nuffield Foundation's immediate concern is that it may be required in consequence of Government economy to choose between sustaining minimum academic activities thereby endangered and, on the other hand, encouraging novel proposals which may in such circumstances find it even more difficult to command a hearing. The danger of any real drying-up of enterprise in the field of research is unlikely to be great. What is endangered is the support of those growing points which from their nature are bound at first to be speculative and often illusory, but which nevertheless when genuine make decisive contributions to human welfare and the advancement of learning.

The present report of the Nuffield Foundation should therefore be read carefully by all who realize the importance under present conditions of preserving independent institutions which are free to experiment and to test the value of new projects in a way that no Government institution could readily do, even if free from the inhibitions already indicated. Both in the introduction to the whole report and in that to the section dealing with fundamental research, and again in that dealing with research into practical problems, it is apparent how great is the opportunity which still confronts the Foundation and with what care the Foundation determines its policy; and valuable as is its support of fundamental biological studies, that given to sociology may well be even more important at the present time. It is perhaps the most hopeful means available to us of averting that very real danger to which the weaker sociological departments in the universities might be exposed in competition with the stronger and more firmly established departments of physical science, in the absence of earmarked grants.

The Carnegie United Kingdom Trust*, like the Nuffield Foundation, is required to promote pioneer efforts for the advancement of social welfare, but in view of its smaller resources, which are only a quarter of those of the Nuffield Foundation, the Trust has concentrated its resources on objects which can be promoted significantly by a relatively small outlay and has consistently withdrawn its support as soon as success or failure has been conclusively demonstrated. When that stage is reached, failures, as, for example, the Bureau of Current Affairs, are abandoned, and successful ventures are transferred to public or voluntary bodies, while the Trust passes to fresh ventures. The most important single enterprise to which the Trustees have set their hands, for example, is the development of library services, on which since 1913 they have spent more than one and a half million pounds. This work will now continue without further financial assistance from the Trustees, and the current report for 1950 records that in this period annual expenditure by public library authorities in the United Kingdom increased from £800,000 in 1911 to £6,700,000 in 1948.

Other instances are cited in this report of the way in which modest experiments by the Trust have developed into institutions with a permanent place in the social structure of Great Britain and now in receipt of an Exchequer grant. So many of the old projects have now for such reasons been dropped that the total sums already earmarked for dispensation in the new quinquennium 1951–55, including £40,000 for the development of museum services, leave a considerable margin, either for the introduction of new schemes of development on a large scale or for financing single pieces of pioneer or experimental work likely to prove of national importance. Some four-fifths of the Trust's budget is, in fact, available for such purpose, and it would seem that the Trustees are now faced with a choice between assisting innovations in social welfare now increasingly in the hands of public authorities, or assisting voluntary enterprises even if they are not strictly of the pioneering type.

The picture displayed by the Carnegie Trust calls for reflexion as much as does that of the Nuffield Foundation's report. Both vindicate abundantly the value of the independent trust in social pioneering and research and the room for such voluntary work to-day. It should be no less clear that the limits of such enterprise and their freedom to experiment will be seriously circumscribed if they are only able to operate in association with public authorities, to which they would of necessity be subordinate. Definition or delineation of function is not easy; but it is clear that much would be lost if the promotion of social advance or of research in general were entrusted exclusively to the State. Both State institutions and voluntary associations have their part to play, and the latter are the repositories of the initiative and freedom to experiment which are always the sources of real advance in science or other human activities. There could be no clearer warning of the need for some such independent institutions, to preserve the atmosphere in which research and the pursuit of learning or the service of mankind are most fruitfully pursued, than the intimation of the narrowness of view and short-sightedness which are liable to cramp official action or policy that is given in the two official papers already mentioned.

* Carnegie United Kingdom Trust. Thirty-seventh Annual Report. Pp. viii 49. (Dunfermline: Carnegie United Kingdom Trust, 1950.)

EVOLUTIONARY THEORY

Animal Evolution

A Study of Recent Views of its Causes. By G. S. Carter. Pp. xv+368. (London: Sidgwick and Jackson, Ltd., 1951.) 30*s*. net.

"ANIMAL Evolution", by Dr. G. S. Carter, is an unusually well-balanced account of the present state of evolutionary theory written with the student reading zoology at a university chiefly in mind. The

discussion is restricted to animals and largely to those in which the reproduction is bisexual. There are two equal parts: (1) the basis of biological fact; (2) the theory of evolution.

In the opening chapter, "The Palæontological Data", the author distinguishes the characteristic patterns of evolution at three levels: micro-, macro- and mega-evolution. In "The Genetical Background", special attention is devoted to the physiology of the gene after a brief presentation of the basic principles of chromosomal organization and of the phenomena of mutation. In "The Species in Zoology", the traditional concept of the systematist —the species as a kind of animal, distinguished from others by at least one consistent character—is contrasted with the species of the naturalist and of the geneticist: a chain of interbreeding communities. The latter is preferred; but it is noted that there is usually convergence toward the same conclusions with respect to living forms. The genetics of differences within and between species is gone into briefly. In Chapter 4, "Intraspecific Categories", it is pointed out that even in common species the occupation of the range is in most cases highly spotty and that this is very important to evolution. The convenient term 'deme' (of Gilmour and Gregor) is used for these partially isolated, and often rather small, communities. The cline and the subspecies are also discussed. In Chapter 5, on "Competition, Isolation and Natural Selection", the author goes at considerable length into the conclusions of statistical genetics as well as into experimental and observational evidence on the success of selection within and between species.

The conclusions of Part 1 are applied systematically to the interpretation of "Micro-evolution" in Chapter 6 and of "Macro- and Mega-evolution" in Chapter 7, continued under the heads "Pre-adaptation", "Evolutionary Trends", "Evolution and the Life-history" and "Rates of Evolution" in the remaining chapters.

In his final conclusions, the author dwells especially on the concept of evolution as a "change in the animal's whole life, in its ecology, habits and behaviour as well as in the organization of its body", and as a process concerned with harmonious genotypes rather than separate genes. He also emphasizes that evolution in bisexual forms is something that happens to populations, not individuals or lineages, and again stresses the importance of the deme as the elementary unit of population.

The reviewer is especially glad to note the emphasis on the genotype and on the deme. He ventures, however, to suggest that these may be tied much more closely together than is done here. In a species with exclusive bisexual reproduction there can be no selection by genotype (beyond a mere summation of separate processes, relating to the average differential effects of the genes) except on the basis of interdeme selection. Such a process occurs wherever the demes are differentiated, in partial isolation, and those with superior adaptation to common environmental or social conditions can contribute more than their share to the next generation by infiltration of neighbouring, less adaptive portions of the species. Random drift of any sort is of more than trivial significance only in conjunction with local selection; but a joint process ensures the differentiation of the genetic complexes of demes, even under common conditions, and thus provides material for interdeme selection.

While Dr. Carter approaches evolution primarily from the point of view of ecology, his conclusions are, I believe, quite in harmony with those of most geneticists on such matters as the roles of micro- and macro-mutation and on the various topics indicated by the chapter titles in Part 2. The greatest gap that he finds in the genetic evidence, that might perhaps be expected to be available, is the absence of known mutations that go beyond mere changes in proportions of parts or replications (including homœotic ones) in such a way as to give a basis for "the appearance in the course of evolution of novelties in the organization of the body where there was no previous differentiation to be modified into them".

Sewall Wright

'THE EXCELLENT MR. RAY'

John Ray

A Bibliography. By Dr. Geoffrey Keynes. Pp. xv+163+4 plates. (London: Faber and Faber, Ltd., 1951.) 50*s*. net.

DR. KEYNES acknowledges in the first sentence of his preface that it was Canon Raven's biography of John Ray, published in 1943, that first opened his eyes to "the extraordinary qualities and endearing character of that remarkable man" and induced him to provide a supplement to Raven's book in the form of a "full-scale bibliography" of Ray's works. This he has done with the attention to detail which we should expect from a vice-president of the Bibliographical Society. Each of Ray's books is fully described, many of them with a photographic facsimile of the title-page, and all with a collation of sheet-signatures and an enumeration of the contents by pages, followed by a list of the copies known to survive, with an indication of the libraries in which they are preserved. With one exception, these libraries are in Britain, and most of them are the great national and university or college libraries. In these categories, however, there are one or two curious and unexplained omissions. For example, while the Universities of Aberdeen, Glasgow and Edinburgh are duly entered, there is no mention of the senior Scottish University, that of St. Andrews, although there is in one of its libraries at least one volume that would have been worthy of record. The abbreviation *YML* occurs in a number of places in the text; but is not included in the "List of Abbreviations" which follows the preface. It may be worth pointing out, therefore, that it is explained on p. 154 in the "Index of Copies Recorded" as referring to "Yale Medical Library".

The author expresses, in his preface, the hope that he has "brought forward evidence in a bibliographical dress" of Ray's "modesty, his loyalty and his integrity". As a matter of fact it is not immediately obvious that he has added a great deal to what we already know on these topics from Canon Raven's "Life". We do, however, learn that Ray, excellent old-fashioned scholar that he was, went to the trouble (and perhaps expense) of reprinting a title-page to rectify two, not very conspicuous, errors in Latinity and that the ignorance, or carelessness, of a bookbinder has left at least two of the surviving copies with the original, incorrect, page, several of the others with the corrected one, and one copy with both.

The volume is finely produced. The printing is what we expect from the Oxford University Press at its best. It is printed on grey paper, and, since the author is a distinguished surgeon as well as a biblio-

grapher, one may assume that he is satisfied that this will avoid eye-strain. Whatever may be the case in conditions of full illumination, this may perhaps not be so in the dim lighting to which we are becoming accustomed in these days of electricity cuts.

Finally, in the "Note on the Portraits of Ray" on p. 151 it is stated that the portrait in the British Museum (Natural History), attributed to Mary Beale, "bears no resemblance to Ray and is difficult to accept as a portrait of him". The present writer, having shared a room with this portrait daily for some ten years, does not find it so hard to believe that it really represents the man whose name is inscribed on it.

W. T. CALMAN

RELATIVITY FOR EXPERIMENTAL PHYSICISTS

Weltsystem, Weltäther und die Relativitätstheorie

Eine Einführung für experimentelle Naturwissenschaftler. Von Prof. Dr. Karl Jellinek. Pp. xv+450. (Basel: Wepf and Co., 1949.) 45 Swiss francs.

THERE is no lack of books on Einstein's theory of relativity, but Prof. K. Jellinek, the author of a five-volume work on physical chemistry and formerly head of the Physical Chemistry Institute of the Technical High School at Danzig, believes that none before his own is really suitable for experimental physicists. It is just as important to-day as when relativity theory first appeared that those engaged in experimental research in physics should have sound ideas about the fundamental concepts of space, time, motion and mass; yet most existing books leave them in a muddle, destroying their old ideas without giving them anything tangible in exchange. The books written for mathematical physicists are often excellent in their own way, but an abstract system of differential equations is rather unsatisfying to the experimentalists, who wonder if this is all they are offered to replace their former belief in a physical ether. The books written for a popular audience avoid abstract mathematics; but they are often superficial, revelling in paradoxes and sensational pronouncements, so that they are more suitable for seekers of entertainment than for seekers of truth.

A third kind of book is needed, which, without sacrificing accuracy, stresses the concrete rather than the abstract and the positive rather than the negative. For example, after giving the usual rejection of Newton's concept of absolute space, Prof. Jellinek asserts emphatically that relativity physics still admits of a universal frame of reference. This assertion is supported by quotations from Einstein, Kopff, Thirring, Beck, Eddington, Tolman and Robertson. The author also believes that relativity physics still admits of belief in a universal ether, with three essential properties. It is, as a whole, at rest relative to the universal frame of reference; it propagates the phenomena of light, electro-magnetism, gravitation, and inertia with constant velocity relative to that frame, irrespective of the velocity of the source; all material bodies, such as electrons, positrons, neutrons, protons, atoms, molecules, and the heavenly bodies represent certain modifications of the ether, through which they move freely. These opinions are supported by quotations from Einstein, Eddington and Weyl. The author also holds some other beliefs about the ether (pp. 23–26), which he recognizes as not generally accepted, but he points out that these can be rejected without affecting the arguments of the rest of the book. As for the space-time continuum, he believes, unlike Eddington, that this should be considered merely as a useful mathematical device and not as a physical reality like the universal frame of reference and the ether, which give a firm basis for clearing away all the paradoxes usually associated with relativity.

The topics mentioned above are dealt with in the preface and two short chapters. A long third chapter (pp. 27–142) deals with the special theory of relativity, on much the usual lines except for the stress on optical experiments and a long discussion of the clock paradox. The fourth chapter (pp. 143–166) gives a brief introduction to tensors. Here and elsewhere the only knowledge that the student is assumed to possess is very small, merely the elements of calculus and of mathematical physics. A long fifth chapter (pp. 167–307) deals with Einstein's theory of gravitation rather differently from usual; to reduce the difficulty, the simplest ideas of the theory are treated at length, before passing on to the important but more difficult aspects. A more general formulation of this theory is given in a short sixth chapter (pp. 308–331). The seventh chapter (pp. 332–381) returns to the questions of a universal frame and ether, and investigates them for three statical cosmological systems, while the eighth chapter (pp. 382–404) investigates them for a non-statical and expanding universe. The ninth chapter (pp. 405–412) gives a brief account of E. A. Milne's kinematical relativity. Unfortunately, Einstein's latest theory was not available when the book was published. In conclusion, there are several mathematical appendixes, a bibliography, and indexes of authors and of subject-matter.

It would be presumptuous for me to pronounce on the soundness of the controversial parts of this book, but it can be safely asserted that they will be found of great interest. It is a pity that the high price may prevent many from examining the book for themselves.

H. T. H. PIAGGIO

BRITISH ORCHIDS

Wild Orchids of Britain

With a Key to the Species. By V. S. Summerhayes. (New Naturalist Series.) Pp. xvii+366+72 plates. (London and Glasgow: Wm. Collins, Sons and Co., Ltd., 1951.) 21*s*. net.

NO group of British plants has attracted more attention than our native orchids. In spite of this, prior to the appearance of Mr. V. S. Summerhayes's book, no real authoritative work on the subject existed. Now we have a comprehensive book dealing with the plants from every point of view, their classification, natural history, ecology and biogeography all receiving adequate attention. Moreover, the volume is well illustrated by a series of colour and other photographs, text figures and maps.

Just after the First World War, British orchids became the objects of much intense research. Taking cognizance of this work, but neglecting such trivialities as *Orchis francis-drucei*, and reducing *O. hebridensis* to its proper level as a subspecies of *O. fuchsii*, Mr. Summerhayes has produced on pp. 107–8 a thoroughly trustworthy list of species. Each of the species admitted to this list is discussed so fully that one wonders at the author's skill in getting the

essential facts into so small a space. Careful scrutiny of his descriptions only serves to confirm their general reliability. This, of course, does not imply that no minor blemishes exist, for such do occur, especially among the dactylorchids.

In the first place, we feel sure that the orchid figured on Plate 38*b* has little to do with the *O. traunsteinerioides* forms recorded from Wicklow and Durham; the differences between the two sets of plants are too strongly marked for that. Furthermore, we doubt the relationship suggested between the Wicklow and Durham plants and true *O. traunsteineri*, of which we possess authentic Irish specimens. We do, however, recognize their obvious affinity with *O. majalis*. As for the origin postulated on p. 295 for *O. traunsteinerioides*, it seems to be impossible for several cogent reasons: the chromosome numbers of the putative parents do not fit, nor, in the case of the Durham plant, do its associates and characters.

In respect of *O. purpurella*, certain pronouncements are made which cannot be harmonized with fact. It is asserted to be the latest flowering of the marsh orchids, and the month of its appearance is given as July. Here, in North Durham, it is the earliest of all. In 1950, a late season, masses of inflorescences were visible on May 29; even this season, on May 12, the flowering spikes were well advanced. Much the same holds true in the Inner and Outer Hebrides, where the flowering of *O. purpurella* is at its height during the last week in May, just ahead of *O. latifolia* and *O. occidentalis*.

Similarly, we cannot understand the remarks concerning the anthesis of *O. fuchsii* and *O. ericetorum* made on p. 272, where we are informed that in the Hebrides the former may precede the latter. According to our observations, made over a period of years, Hebridean *O. ericetorum*, even high up the mountainsides, commences to flower in the middle of May with *O. fuchsii* ssp. *hebridensis* following about June 15. Thus in 1950, in Lewis, Harris, South Uist and Eriskay, although there was some overlap in July, *O. ericetorum* had quite disappeared when *O. fuchsii* was at its best.

The sections devoted to ecology and biogeography now come up for comment. Concerning the former, we have nothing but praise. However, in the case of the biogeography, the accounts should be received with some measure of caution. On p. 69 the pronouncement that the Ice Age occurred 10,000–100,000 years ago is incorrect. Had the latter date been given as 600,000 years ago, we should have had a much closer approximation to the truth. Again, Mr. Summerhayes is inclined to emphasize older conceptions about the history of our flora and fauna. He seems to be unaware that recent investigations have pointed strongly to the possibility that a not inconsiderable portion of our biota migrated to the British area during the last Interglacial Period, or even during favourable interstadial phases in the Upper Pleistocene glaciation. Such contingents, forced westward to suitable refugia when more rigorous conditions returned, and released finally as the glaciers waned, may well be responsible for some of the distributional anomalies so puzzling to plant geographers.

As an appendix we have an excellent and workable key to the species described, followed by a useful glossary, a bibliography and a series of distributional maps. The latter follow the usual practice of blackening the whole of a vice-county when only a single station is concerned. For example, although *Gymnadenia conopsea* and *Anacamptis pyramidalis* are confined in the Outer Hebrides to the small Isle of Fuday, the whole of v.c. 110 is blackened; such a procedure may easily vitiate serious phytogeographical researches.

Botanists owe a debt of gratitude to Mr. Summerhayes for producing such an excellent book, and we unhesitatingly recommend it to all interested in British orchids.

J. W. Heslop Harrison

INSECTS AND HYGIENE IN BRITAIN

Insects and Hygiene

The Biology and Control of Insect Pests of Medical and Domestic Importance in Britain. By Dr. James Busvine. Pp. xiv+482. (London: Methuen and Co., Ltd., 1951.) 30*s*. net.

INSECTS do not play a major part in the transmission of human disease in Great Britain, and the damage which they do to stored foods, to clothing, to the structural timbers of buildings, or to furniture is on the whole insidious, and although in the aggregate it is extensive enough, much of it passes almost unnoticed. But as every applied entomologist, every medical officer of health and, indeed, every housewife knows there are a great many troublesome insects in our midst and it is not always easy to obtain the information about them that is necessary for their effective control. Dr. Busvine has produced a truly scientific and very practical treatise on this diverse collection of insects. He has made the attempt of setting out within a single volume the general principles of pure entomology—systematics, anatomy, physiology and ecology, the general principles of applied entomology, and the practical details for the diagnosis and treatment of every pest problem in the home or in the warehouse, in foodstuffs, in timber or on the body. Many of the topics are necessarily treated in a brief and superficial style. But on the whole the author has succeeded in maintaining an admirable balance in the treatment that he gives to all sides of the subject.

In these days when new synthetic insecticides discovered in the past ten years have brought about a revolution in our powers for destroying insects by chemical means, it is sometimes forgotten that most of the insects that trouble the health of man can be controlled by common cleanliness. It was improvements in cleanliness and not insecticides which led to the disappearance of the bed-bug from the houses and the louse from the persons of the upper classes of Britain in the nineteenth century. The flea cannot maintain itself in clean houses or clean cinemas; nor can the house-fly breed in clean back-yards. It is a notable feature of Dr. Busvine's book that although the sections dealing with insecticides and their uses are particularly good, the biological methods of control—of which domestic hygiene is often the most important—are given full weight.

But the control of insects in human communities is often impossible without the backing of the law. In Britain the local authorities have varied legal powers for dealing with insects infesting houses, with verminous persons or with divers nuisances connected with insects. It is useful to find all these matters set out briefly in this book. There are also keys for the identification of most of the insects to which reference is made and an appendix giving chemical details about most of the insecticides now in use.

V. B. Wigglesworth

Laboratory Physics

By J. H. Avery and A. W. K. Ingram. Pp. xi+439. (London: William Heinemann, Ltd., 1950.) 16*s*.

TWO science masters, who obviously have first-hand and wide experience of the difficulties which confront sixth-form and first-year university students when performing the standard physical experiments, have combined to write this excellent text-book. Not only is the student encouraged to make some of the apparatus himself—there are brief instructions on soldering, glass-blowing and drilling, etc., to help him—but also the teacher will find the more precise specification of apparatus than is usual in text-books of this kind most useful in setting up the experiments. Detailed descriptions of nearly two hundred experiments grouped into sections on mechanics and properties of matter, heat, light, sound, magnetism, electricity, and—one which will appeal perhaps more to the technical colleges—electronics are given. The authors state that they were encouraged to include this last section because of the considerable quantity of ex-Government equipment now available to the public. Exercises, problems, a good bibliography, together with an introductory section containing some excellent advice on laboratory notebooks, errors and graphical methods, complete the book.

The diagrams are on the whole clear, but some might with advantage have been larger. Enough theory is given with each experiment to explain the principle and method employed. Natural and forced convection are discussed and the distinction between them carefully emphasized. The authors do not hesitate to point out where difficulties arise, as, for example, in the determination of the internal resistance of a primary cell, and the student is quite correctly referred to the late Sir Cyril Ashford's excellent article on this subject for further information. The 'real is positive' sign convention is used in the light section, but the diagrams are so drawn that the 'new Cartesian' convention can also be applied to them. A regrettable omission is Owen's method for the determination of neutral points by directional loci.

S. WEINTROUB

Etat actuel de la chimie et de la physique des molécules géantes

Science de base des industries des matières plastiques. Par Prof. H. Mark, avec la collaboration de Prof. T. Alfrey et Prof. R. B. Mesrobian. Pp. xv+548. (Paris: Masson et Cie., 1950.) 3150 francs.

THIS substantial book provides an up-to-date, detailed and excellently documented account of the physics and chemistry of large molecules. A useful feature is the full description given of the light-scattering method for the determination of molecular size and shape. The mechanical properties of polymers are treated thoroughly, as is the phenomenon of 'ageing'. On the chemical side, copolymerization and emulsion-polymerization are selected for discussion of the scientific principles involved. There is an interesting final chapter on the preparation and properties of *cyclo*-octatetraene, included because of its interest in connexion with the synthesis of new monomers. The book is based on a series of lectures given by Prof. H. Mark in Liège in 1948, and the Belgian editors are to be congratulated on their initiative and on their meticulous translation and excellent presentation of the material.

D. P. RILEY

A Short Guide to Chemical Literature

By Dr. G. Malcolm Dyson. Pp. vii+144. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1951.) 8*s*. 6*d*. net.

IN arrangement and general treatment this book is an up-to-date version of Dr. F. A. Mason's "An Introduction to the Literature of Chemistry" published a quarter of a century ago, though the treatment is somewhat fuller, and a chapter, "Works of Reference on Medicinal Chemicals", replaces that on the "Special Literature on Dye Chemistry" in Mason's book. There is further a good chapter on "Making a Search in the Literature" which extends that in Mason's book, and an appendix giving an example of an organic chemical search. The book, moreover, contains two other useful appendixes: the first of these deals with some old and obsolete journals; the second gives a list of journal years and volume numbers more extensive than that to be found in "The Chemist's Yearbook" and covering the interruptions and changes of the past ten years or so. The book is admirably designed to serve its purpose. It is admittedly selective and cannot well be criticized on the grounds of omissions. One or two slight suggestions might, however, be ventured. The section dealing with historical text-books omits Bugge's "Das Buch der grossen Chemiker". If only for its copious references, this is a much more valuable work than several of those included. Among the list of chemical periodicals, the omission of the *Transactions of the Institution of the Rubber Industry* is surprising, and the *American Dyestuffs Reporter* might have been included among those dealing with dyes and textiles. Similarly, *Biological Abstracts* or *Abstracts of World Medicine* would appear to be at least as worth including among the abstract journals as *Excerpta Medica*.

Audubon Water Bird Guide

Water, Game and Large Land Birds, Eastern and Central North America from Southern Texas to Central Greenland. By Richard H. Pough. (Sponsored by National Audubon Society.) Pp. xxviii+352+48 plates. (Garden City, N.Y.: Doubleday and Company, Inc., 1951.) 3.50 dollars.

THIS excellent little book by R. H. Pough is a guide to the birds to be found on or near the marshy and watery areas of eastern and central North America. It is published under the sponsorship of the National Audubon Society, the many bird portraits in colour being by Don Eckelberry, while the black-and-white sketches are from the pencil of E. L. Poole, both of whom are worthy upholders of the tradition of the great bird artist Audubon.

The field covered is a wide one. It embraces not only truly aquatic species such as grebes and petrels but also birds of the marshes and birds associated with marshy areas. We read of herons, bitterns and egrets, plus ducks, geese and swans; we come to waders and even game birds and birds of prey.

A considerable amount of interesting information is given under the heading of 'habits', including the greatest age known to have been attained by the species under consideration; for example, the osprey twenty-one years, golden eagle thirty years and gannet sixteen and a half years. But the last-mentioned would not necessarily be an old bird; it might, indeed, be but in the prime of life, for there are grounds for believing the gannet lives long.

FRANCES PITT

OBSERVATION OF A LINE IN THE GALACTIC RADIO SPECTRUM

Radiation from Galactic Hydrogen at 1,420 Mc./sec.

THE ground-state of the hydrogen atom is a hyperfine doublet the splitting of which, determined by the method of atomic beams, is 1,420·405 Mc./sec.[1]. Transitions occur between the upper ($F = 1$) and lower ($F = 0$) components by magnetic dipole radiation or absorption. The possibility of detecting this transition in the spectrum of galactic radiation, first suggested by H. C. van de Hulst[2], has remained one of the challenging problems of radio-astronomy. In interstellar regions not too near hot stars, hydrogen atoms are relatively abundant, there being, according to the usual estimate, about one atom per cm.^{3}. Most of these atoms should be in the ground-state. The detectability of the hyperfine transition hinges on the question whether the temperature which characterizes the distribution of population over the hyperfine doublet—which for want of a better name we shall call the hydrogen 'spin temperature'—is lower than, equal to, or greater than the temperature which characterizes the background radiation field in this part of the galactic radio spectrum. If the spin temperature is lower than the temperature of the radiation field, the hyperfine line ought to appear in absorption; if it is higher, one would expect a 'bright' line; while if the temperatures are the same no line could be detected. The total intensity within the line, per unit band-width, should depend only on the difference between these temperatures, providing the source is thick enough to be opaque.

We can now report success in observing this line. A micro-wave radiometer, built especially for the purpose, consists mainly of a double superheterodyne receiver with pass band of 17 kc., the band being shifted back and forth through 75 kc. thirty times per second. The conventional phase-sensitive detector and narrow (0·016 c./s.) filter then enable the radiometer to record the apparent radio temperature *difference* between two spectral bands 75 kc. apart. These bands are slowly swept in frequency through the region of interest. The overall noise figure of the receiver, measured by the glow-discharge method[3], is 11 db., and the mean output fluctuation at the recorder corresponds to a temperature change of 3·5°. The antenna is a pyramidal horn of about 12° half-power beam-width. It is rigidly mounted at declination −5°; scanning is effected by the earth's rotation.

The line was first detected on March 25, 1951. It appeared in emission with a width of about 80 kc., and was most intense in the direction 18 hr. right ascension. Many subsequent observations have established the following facts. At declination −5° the line is detectable, by our equipment, over a period of about six hours, during which the apparent temperature at the centre of the line rises to a maximum of 25° above background and then subsides into the background. The source appears to be an extended one approximately centred about the galactic plane. The frequency of the centre of the line, which was measured with an accuracy of ±5 kc., was displaced some 150 kc. above the laboratory value, and this shift varied during an observing period. Both the shift and its variation are reasonably well accounted for by the earth's orbital motion and the motion of the solar system toward Hercules. The period of reception shifts two hours per month, in solar time, as it ought to.

Some conclusions can already be drawn from these results. Extrapolation of radio temperature data for somewhat lower frequencies[4] suggests that the background radiation temperature near the 21-cm. line is not more than 10° K. Then the hydrogen spin temperature is not more than 35° K., if the source is 'thick'. But we can calculate the opacity of the source on the assumption of a spin temperature of 35° K. and 1 atom/cm.^{3}, using only the observed line-width and the matrix element of the transition in question, and we obtained 900 light-years for the absorption-length. As this is much smaller than galactic dimensions, we conclude that the temperature observed corresponds indeed to the spin temperature at the source. To the extent that 'self-absorption' contributes to the observed line-width, the true absorption length at the frequency of the centre may be *less* than that computed. Further evidence for relatively high opacity is the absence of large frequency-shifts, which would be expected to arise from galactic rotation were the opacity-thickness comparable to the size of the galaxy. This conclusion is contrary to the prediction of Shklovsky[5], who has recently discussed the possibility of detecting galactic line radiation.

We have made rough theoretical estimates of the efficacy of various processes through which energy is exchanged between the hydrogen hyperfine levels and the other thermal reservoirs in the interstellar matter plus radiation complex. Of these we find exchange with the radiation field (involving spontaneous emission) and exchange with gas-kinetic energy of the hydrogen atoms (via H–H collisions) much the most important, with the latter process probably dominant. This is consistent with the observation, and if correct implies that the gas-kinetic temperature of the hydrogen exceeds, but not greatly, the spin temperature. The estimated spin relaxation time for these processes is of the order of 10^5 years.

This work was assisted by a grant from the Rumford Fund of the American Academy of Arts and Sciences.

H. I. Ewen
E. M. Purcell

Lyman Laboratory,
Harvard University,
Cambridge,
Mass.
June 14.

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[2] van de Hulst, H. C., *Nederl. Tij. Natuurkunde*, 's-Gravenhage-Martinus Nyhoff, **11**, 201 (1945).
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The Interstellar Hydrogen Line at 1,420 Mc./sec., and an Estimate of Galactic Rotation

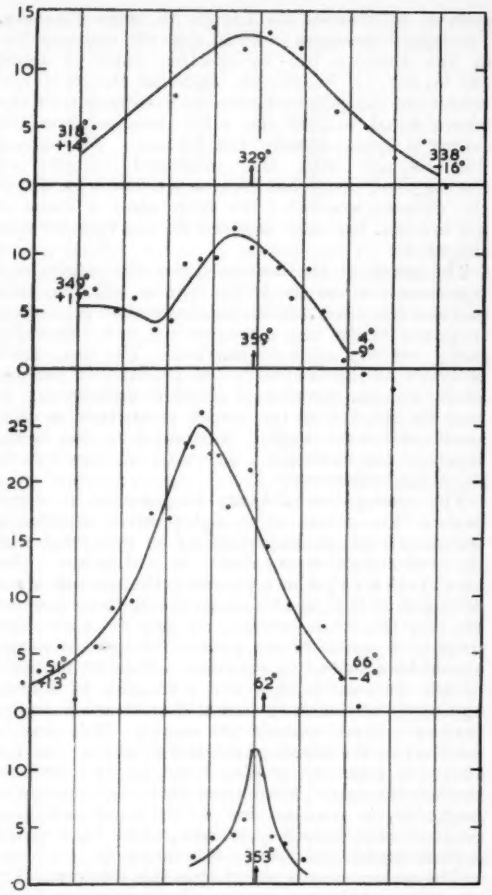
FOLLOWING a suggestion made by Dr. H. C. van de Hulst in 1944 [1], attempts have been made to measure the radiation at 1,420 Mc./sec. (λ21 cm.) emitted by atomic interstellar hydrogen. The first experimental evidence for the presence of this interstellar emission line was obtained by Ewen and Purcell on March 25, 1951 (see the preceding communication). In the Netherlands, the first successful measurements were made on May 11.

The receiver consists of a double superheterodyne instrument, with a crystal-controlled first local oscillator, which is switched between two frequencies 110 kc. apart thirty times per second by a reactance modulator. By varying the frequency of the second local oscillator, the two frequencies can be moved together through a 4-Mc. wide pass band at 1,420 Mc. The pass band of the second i.f. channel is 25 kc. wide. Behind the usual phase-sensitive detector a narrow-band filter with a time constant of 12 sec. is used. So the difference between two frequency bands 110 kc. apart is measured. The noise factor of the receiver has not yet been measured. The losses in the coaxial antenna cable are rather high, and an effective noise factor of the whole receiving system of 25 has been deduced from other measurements with the sun as a source of noise. Important parts of the receiver have been constructed at the Philips Laboratory in Eindhoven under the supervision of Dr. F. L. Stumpers.

The receiver has been mounted behind a movable paraboloid of 7·5 m. aperture and 1·7 m. focal-length at the radio station at Kootwijk, which was kindly put at our disposal for these measurements by the Radio Department of the Post and Telegraph Service. The beam-width at half-power is 2·8°.

The results of the measurements made on a few of the first tracings are shown in the accompanying graphs. While these tracings were being made, the instrument was left in a fixed position relative to the earth, the motion across the sky being provided by the earth's rotation. The frequency of the second local oscillator is switched every 3 min. between positions in which either of the two pass bands coincides with the spectral line. The first position gives a positive, the other a negative, deflexion on the recording meter. The curves show the intensity as function of the right-ascension; the interval between successive vertical lines is 20 min. of time. The point at which each sweep crossed the galactic equator has been marked with an arrow, accompanied by a number giving the corresponding longitude. The galactic co-ordinates at the beginning and end of each tracing have also been indicated. The curves shown may be slightly distorted because the radial components of the orbital motion of the earth, of the sun's motion relative to the nearby interstellar clouds and of differential galactic rotation are different for the various directions. However, we do not believe that these effects will have seriously affected the general shapes of the records, except for latitudes less than 1½°, where in some directions the line is greatly widened by galactic rotation, and the measured intensities will be too small.

It is evident from the wide spread in galactic latitude that the clouds observed must be relatively close to the earth. From the width of the emission line observed in the region of the centre of the



Galaxy, where the rotation of the galactic system does not affect the line, it is found that the random velocities average about 5 km./sec. in one co-ordinate, which agrees approximately with what had been found from absorption lines in the visual region. With such small velocities it is unlikely that the gas extends to more than an average distance of about 50 parsecs from the galactic plane. With an average latitude of the order of 8°, the gas seen in the general direction of the centre cannot then be farther away than 300 or 400 parsecs. In Cygnus the distance may be twice this amount.

These small distances might be taken as an indication either that the more central parts of the Galaxy are devoid of atomic hydrogen, or else that within a distance of between 500 and 1,000 parsecs in the galactic plane the gas becomes optically thick in the wave-length of this line. Although we should like to reserve a definite judgment until more complete measures have been obtained, we believe the latter alternative is the more probable on the basis of the results so far available.

In order to test the presence of radiating hydrogen in the inner regions of the Galaxy, measures have been made across the Milky Way at $l = 355°$, 30° from the centre, where the change of frequency due to differential galactic rotation should make it

possible to observe the gas up to large distances. Provisional measures indicate that the emission line in this direction has an effective width of about 330 kc./sec., or 70 km./sec., and that the rotational velocity of the galactic system at a distance from the centre equal to half the sun's distance from the centre is approximately 190 km./sec. This agrees well enough with the rotational velocity of 205 km./sec. computed from a schematic model of the galactic system[2]. (In both cases a value of 270 km./sec. has been assumed for the rotation near the sun.)

The graph at the bottom shows the results of a registration across the Milky Way at 355° longitude and at a frequency 250 kc./sec. lower than the normal frequency of the line, corresponding to a differential radial velocity of +55 km./sec. The gas clouds observed at this frequency are presumably situated at an average distance of about 8 kiloparsecs. It may be noted that the spread in latitude is quite small, and may roughly correspond to the beam-width of the instrument, as would be expected for these large distances.

The tracings reveal many irregularities in distribution. The extension to high positive latitudes in the second graph may possibly be connected with the well-known dense clouds in Ophiuchus. The maxima in the Cygnus region lie systematically about 2½° south of the galactic circle at longitudes between 40° and 45°, while between 56° and 62° they occur roughly 3° north of the plane. Though no weight should be attached to the exact differences in height of the various sweeps, the intensities in Cygnus appear to be definitely higher than in other regions (except in that opposite the centre). This may be ascribed to the effects of galactic rotation. The fact that the intensity *is* also lower in the direction towards the centre, where these effects are presumably negligible, is possibly due to the superposition of continuous background radiation, which has probably a considerable intensity in this direction.

The measurements reported in this communication are of a provisional nature. Improvements in the receiver are possible, and are now being made in preparation for more systematic measurements.

The investigation has been made possible by grants from the Netherlands Organization for Pure Research (Z.W.O.).

C. A. Muller
J. H. Oort

Netherlands Foundation for Radio Astronomy,
Kootwijk Radio Station.
Observatory,
Leyden.
June 26.

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The following cable dated July 12 has been received from Sydney, N.S.W.:

Referring Prof. Purcell's letter of June 14 announcing the discovery of hyperfine structure of the hydrogen line in galactic radio spectrum, confirmation of this has been obtained by Christiansen and Hindman, of the Radio Physics Laboratory, Commonwealth Scientific and Industrial Research Organization, using narrow-beam aerial. Intensity and line-width are of same order as reported, and observations near declination 20° S. show similar extent about galactic equator. J. L. Pawsey

VARIATIONS IN THE CHEMICAL COMPOSITION OF STRATOSPHERE AIR

By Dr. K. F. Chackett, Prof. F. A. Paneth, F.R.S., P. Reasbeck and B. S. Wiborg

Londonderry Laboratory for Radiochemistry, University of Durham

In a previous article[1] analyses of upper air samples obtained from 52–66·5 km. height by means of *V*2 and Aerobee rockets were described, and it was shown that in all cases the composition of the samples was nearly the same as at ground-level, with respect to the ratio of helium, neon and argon to nitrogen. At the same time it was pointed out that some uncertainty must be attached to the helium values because the air was sent to us in glass vessels. Recently, we received, from the University of Michigan, stratosphere air in the original steel bottles in which the samples had been collected; a new and improved sampling technique had been employed, and in the meantime our method of analysis had also been further developed. We now wish to communicate our latest results, which provide evidence for gravitational separation between 64·3 and 71·8 km. height (M.S.L.). Details of the experimental procedure will be published later.

We owe the following information about the new sampling arrangements to the scientific workers of the Department of Aeronautical Engineering, University of Michigan[2]. Three evacuated steel bottles were located immediately behind the hollow nose cone of an 'Aerobee' rocket. The bottles were soldered to thin copper tubes, one inch in diameter, the sealed-off ends of which projected into the cone. The latter was ejected automatically just before sampling. At a predetermined instant a steel knife was arranged to cut through one tube, and five seconds later this was squeezed shut at a lower point by a pyrotechnically operated vice. The second and third bottles were opened and shut at successively later times. Control experiments had shown that the sealing mechanism gave satisfactory vacuum-tight seals without the use of solder.

A successful flight took place from the White Sands Proving Ground in New Mexico on December 19, 1950. After recovery, the three steel bottles were dispatched to us and their contents analysed by our micro-method for oxygen, nitrogen and the inert gases helium, neon and argon. Since our previous work, an entirely new apparatus had been built with several improvements over the old model. Thus, the air pipette was of smaller volume, enabling us to take smaller amounts of gas (between 0·07 and 0·10 c.c. s.t.p. for each analysis); the same pipette was used for the helium–neon analysis and for the nitrogen–argon analysis; and the fractionating column consisted now of fifteen units instead of twelve, each smaller than formerly, and operated by means of a mechanical device which could be set to perform any number of fractionations and then stop.

In general, runs on the stratosphere air were sandwiched between runs on ground-level air, so that a good check could be kept on the satisfactory working of the apparatus. As we found in the earlier work, the oxygen content of the samples was much below normal in spite of the fact that the sampling vessels were always cold. It is impossible to assume that there really is this deficit of oxygen in the

Sample		Height (km.)	Date of sampling	Date of first analysis	Oxygen	Helium	Neon	Argon
16*A*	Glass vials	49·6–53·6	2.6.49	4.8.49	0·61	0·96	0·98	1·00
25*D*		50·4–53·3	6.12.49	17.4.51	0·60	0·98	1·00	1·00
15*B*		53·6–57·7	2.6.49	25.7.49	0·12	1·00	1·00	1·01
19*D*		54·7–58·3	21.7.49	6.3.51	0·00	1·01	1·45*	1·01
3*B*		55·4–65·5	27.5.48	1.12.48	<0·02	0·98	0·99	0·99
1*B*		61·1–72·0	9.10.47	4.1.48	<0·02	0·93	1·00	1·01
B-6	Steel bottles	64·3–67·0	19.12.50	12.6.51	0·07	1·44	1·08	0·93
B-8		67·0–69·6	19.12.50	25.6.51	0·25	2·02	1·18	0·89
B-9		69·6–71·8	19.12.50	9.5.51	0·03	1·49	1·07	0·95

upper air, and we suppose that the walls of the bottles and connecting tubes were so well cleaned during the initial pumping and degassing that they were able to take up most of the oxygen at room temperature during the interval—five to six months—between the flight and the analysis.

In view of the ever-present danger of a partial loss of oxygen during sampling, it has always been our habit to express the figures for the rare gases in relation to oxygen-free air or, in other words, to the nitrogen + argon content; since we have now found some variations in the argon content, we think it best to relate all figures to nitrogen. The accompanying table gives for each gas the value of the ratio:

$$\frac{\text{volume of gas, relative to nitrogen, in sample}}{\text{volume of gas, relative to nitrogen, in ground-level air}}.$$

For convenience we have included in the table the results of previous analyses also. All figures are quoted to two places of decimals only, although the errors calculated from individual experimental results (usually two or more) are often less than one-half per cent. The figure marked with an asterisk is unreliable owing to contamination by, apparently, hydrogen.

The first six samples in the table show no appreciable variation in chemical composition from ground-level air. The results of 16*A*, 15*B*, 1*B* and 3*B* have been published before[1]; 25*D* and 19*D* were later analysed for the special reason that McQueen[3] had found in air from these samples as well as from 15*B* a shift in the relative proportion of the nitrogen isotopes which he interpreted as an indication of gravitational separation. Our figures are in contradiction to this interpretation, as has already been pointed out with respect to 15*B* by the workers at the University of Michigan[4], whose own experiments confirm our findings. However, while we are certain about the correctness of the analyses, it is perhaps not impossible that contamination by ground-level air during the process of sampling has obscured shifts in the chemical composition.

Quite different are the results of the last flight. In every one of the three steel bottles we found a marked increase of the helium and neon content and a deficit of argon. The shift of the helium-percentage is greater than that of the other two gases. All this is in qualitative agreement with the supposition that the samples come from a region in the stratosphere where gravitational separation has been effective.

It is the first time that such an effect has been observed with certainty. In earlier experiments we found a small increase of helium at heights between 21 and 25 km., and M. Shepherd and E. Regener a deficit of oxygen between 19 and 29 km.[5]; but we were reluctant to consider the evidence as conclusive[6]. It is not safe to rely on helium analyses if the sample has been stored in a glass vessel, and contact with stop-cock grease is sufficient to reduce appreciably the oxygen content[1]. In Regener's experiments there was a further source of possible error: his stratosphere sample was during the whole time in contact with metallic copper, so that, according to our experience, disappearance of some oxygen was to be expected.

Of the three steel bottles used in the last flight, the first one, *B*-6, opened and sealed perfectly. As to *B*-8, we were informed that the opening may have been poor as the knife was at the time of recovery in an unexpected position. In *B*-6 we found 0·388 c.c. of air (s.t.p.), in *B*-8 only 0·185, but as the sample came from a greater height there seems to be no reason to suspect the essential correctness of the sampling; it is qualitatively in agreement with expectations to find in *B*-8 a stronger shift in composition than in *B*-6. Concerning *B*-9, however, we doubt whether the sample is representative for the height given. Here, as well as in *B*-8, the opening might have been incomplete as the knife had cut only half-way; nevertheless, we found in this bottle 0·535 c.c. (s.t.p.), a considerably greater volume of air than in either *B*-6 or *B*-8, in spite of the greater height. As at the same time the shift in composition is not even as strong as in *B*-6 (see especially the very accurate argon figures) we strongly suspect that, after the sampling at about 70 km., the sealing was not perfect and that afterwards some ground-level air had leaked in; after recovery the sealed copper tubing was covered with glyptal, but that does not exclude the possibility of a previous leakage. If from the volume of gas measured in the other bottles we calculate the amount to be expected in *B*-9, we find that only about a fifth of the quantity contained came from 70 km.; assuming the rest to be ground-level air, we can allow for this contamination. Instead of helium 1·49, neon 1·07 and argon 0·946 we obtain the following 'corrected' figures for *B*-9: helium 3·44, neon 1·35 and argon 0·73. We feel that this procedure is the best in the circumstances, but even if the latter figures are nearer the true value than those obtained by direct analysis, they are very rough.

Our figures do not agree quantitatively with any simple theory. This, however, is scarcely surprising, since the samples may be the result of many alternating phases of gravitational separation and of remixing. Another possibility is that an initially homogeneous layer began to separate gravitationally, but owing to the different mean velocities of the constituent molecules the helium reached its equilibrium concentration with respect to nitrogen more completely than the heavier gases. Taking the helium ratios for *B*-6 and *B*-8 as representing the composition at the midpoints of the sampling intervals, it may be shown that a good fit is obtained with a temperature of 230° K., and with the midpoint of *B*-6 as 3·0 km. above the level at which separation commences. The calculated figures for the neon in *B*-6 and *B*-8 are then 1·13 and 1·26, the argon figures 0·83 and 0·71 respectively; the calculated helium,

neon and argon ratios in *B*-9 are then about 2·8, 1·4 and 0·6 respectively. These calculations are, however, of little value except as an illustration of the deviations from a simple theory, if only because it is estimated that the actual temperature at these heights is nearer 280° K.[7].

Since it is proved now that the sampling technique of the Michigan team of scientific workers can reach heights in which diffusive separation becomes effective, it is hoped that more samples from these, and from even greater, heights will soon be collected. Only if more experimental material is available will it be possible, and worth while, to try to develop precise ideas about the stillness, or otherwise, of the stratosphere at heights from 64 km. upwards. So long as about 0·1 c.c. of air (s.t.p.) can be collected (containing normally 5×10^{-7} c.c. helium, $1{\cdot}8 \times 10^{-6}$ c.c. neon and $9{\cdot}3 \times 10^{-4}$ c.c. argon), we shall be able to carry out on each sample at least one analysis of these three gases with the present accuracy of 1 per cent. Air from greater heights may show such marked variations in composition that still smaller samples and, accordingly, a somewhat reduced accuracy, will give valuable information.

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MODERN INSECTICIDES AND THE BALANCE OF NATURE*

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SINCE man first scratched the soil in an endeavour to obtain more food, he has had to contend with the vicissitudes of a hostile environment. Of the factors inimical to increased productivity, few are of greater significance than the direct and indirect toll exacted by insects and their allies; the loss in world crop-production alone being at least ten per cent, and double that figure according to other estimates. This is not so remarkable if it is borne in mind that nearly three-fourths of all species of animals are insects.

For hundreds of years, therefore, man has been driven of necessity to combat his insect enemies. Within the past decade, however, chemists have synthesized new pesticides which have penetrated the realms of plant protection, veterinary and medical hygiene, at great speed. Despite the remarkable insecticidal and acaricidal properties of these new substances they are not the universal panaceas which was portended in the first flush of enthusiasm. They have their limitations and dangers, and ignorance of their ultimate effects has led to their abuse. For good or ill, however, there is no doubt that these artificial aids to pest control have received a warm welcome from diverse sources.

The two main groups of these 'wonder' insecticides are the chlorinated hydrocarbons and the organophosphates. Members of both groups are now in use throughout the world in connexion with pest problems which seemed well-nigh insoluble. With the advent of DDT, BHC, DNT, HETP, etc., man's potential control over the lower orders was never so powerful as it is to-day, and the 'discovery' of these chemicals will rank as a major contribution of science to the world.

Some of the original claims made for DDT were exaggerated; but used with discretion, it is probably the most generally useful insecticide available being highly toxic to most insects. A unique feature—not without danger—is its extraordinary persistency, which renders DDT of special value where good persistence on foliage is essential. Thus, DDT has proved its effectiveness against a variety of plant-feeding caterpillars, weevils, pollen and flea beetles, several moths, and against the cotton jassid in the Sudan. Mosquitoes and other flies, fleas and lice, are highly vulnerable. Throughout the stock-rearing countries of the world, this 'penicillin of insecticides' is proving a boon to harassed stockmen in their struggle against blowflies, keds and ticks. Fortunately, DDT is less harmful to bees than was first suspected; but no undue risks should be taken in this respect, such as spraying open blossom.

Another 'wonder' insecticide is the gamma-isomer of benzene hexachloride. Although of lower persistency, it has a degree of volatility not possessed by DDT. This accounts for its spectacular results as a soil-insecticide, especially against wireworms—formerly responsible for losses of 0·5 cwt. per acre of English wheat and oats, for every 100,000 wire worms per acre. In addition, BHC gives good control of certain aphides, sawflies, root-maggots and leaf-miners. Abroad, the age-old menaces of locusts and termites may eventually be eliminated by this new weapon. So toxic to locusts is gamma-BHC that 3 gm. are enough to kill a ton of them. Equally remarkable results are being obtained in the control of mange-mites and ticks; for example, the scab-mite which has ravaged the sheep-flocks of the Old World for two thousand years can now be eradicated by one dipping in a BHC suspension.

The synthetic organophosphates originated in Germany, during the Second World War, as substitutes for nicotine. Of these, HETP was the first to be used commercially; but has been partially superseded by DNT or parathion, of which the outstanding feature is its extreme toxicity to aphides and spider-mites—both largely unaffected by the chlorinated hydrocarbons. Parathion is non-ovicidal and seldom persists actively on foliage for longer than three days. Of special interest is the discovery by American and Australian investigators that parathion gives commercial control of chrysanthemum eelworm, thereby suggesting a solution of the eelworm problem in other crops.

These are the principal achievements of three insecticides in world-wide use; but so many are ap-

* Substance of a paper read on August 10 before Section D (Zoology) of the British Association meeting at Edinburgh.

pearing on the market that some may be outmoded sooner than seemed probable a few years ago. As these chemicals have not been received with universal approbation, what are the charges that have been levelled against them? The presumed hazards to human health, through the cumulative effects of toxic residues, falls outside the scope of this paper, so that the other potential danger can now be considered.

Two years ago, in a contribution to *Discovery*, I remarked that "because of the greater susceptibility of numerous parasites and predators than the pests themselves, and the rapid resurgence of pests in the virtual absence of natural enemies, the indiscriminate use of these new chemicals might seriously upset the balance of nature". To what extent has this prognostication materialized?

Evidence from numerous sources leaves no doubt that sprays of DDT on fruit-trees lead to an increase of 'red spider' (*Paratetranychus* spp.). This was presumed to be due to destruction of natural enemies; but more recent work in the United States and in Holland supports the view that DDT has also a direct stimulating effect upon the reproduction of the mites. Nevertheless, DDT can kill thirty or more of the insect enemies of red spider, and if used soon after bud-burst it may destroy many beetles which act as pollinators. Mealybugs and many species of 'greenfly' are practically unaffected by DDT, and tend to increase when it is used alone. This is due to its lethal action upon the larvæ and adults of predators such as hover flies, lacewings and ladybird beetles. Similarly, the use of DDT against certain root maggots intensifies the injury, apparently by killing predators of the puparia.

Recent studies of the fauna of apple-orchards in Nova Scotia have revealed a tangled skein of interrelationships between phytophagous mites and insects, parasites, predatory mites, bugs and beetles: additional complications having followed the use of insecticides and fungicides. In general, it seems that the populations of red spider and scale insects in so-called 'neglected' orchards are lower than in orchards subjected to spraying with DDT. In several areas, DDT has so reduced the activities of the *Aphelinus* parasite of woolly apple-aphid that the latter has required treatment with BHC. Aerial application of DDT (1 lb./acre) has given reasonable control of forest defoliators in the United States, without causing permanent damage to invertebrates serving as fish-food in the streams and lakes; but in another investigation the density of invertebrates was greater one year after spraying than before, suggesting some interference with the natural balance. It is considered inadvisable to use more than double the above rate to avoid harm to birds, and treatment should not be carried out during the nesting season.

Charges against BHC include the causation of greater injury by cotton bollworms (*Heliothis* spp.) due to destruction of predatory bugs, and an increase of sugar cane borer (*Diatræa*) through destruction of the egg-parasites (*Trichogramma* spp.). Nor is there any doubt that dusts of BHC are extremely toxic to bees and other pollinators, so that on no account should they be used on open blossom. Beans dusted with this chemical to control black dolphin (*A. fabæ*) have failed to set seed—a result of interference with cross-pollination. Earthworms are not seriously affected, whereas older insecticides such as derris and lead arsenate are highly toxic to them. Neither DDT nor BHC gives the spectacular knockdown of pyrethrum; but like derris, both are deadly to fish. Although parathion is potentially less dangerous to beneficial insects because of its much lower persistence than either DDT or BHC, it is quite toxic to many predators of aphides and spider-mites.

The adverse effects of insecticides on beneficial species is by no means a new problem; but the potency and persistency of modern synthetics have raised specific problems concerning their appropriate application to avoid abuse. It has been realized for many years that tar-oil winter washes were directly associated with the increase of red spider in the orchards of southern England, and that they were not favourable to the establishment of the imported parasite (*A. mali*) of woolly apple-aphid. American investigators concluded in 1931, and again in 1935, that sprays of lead arsenate were seriously reducing the efficiency of an important parasite of the codling moth, and that egg-parasitism was lowest in orchards tended according to the most up-to-date rules of husbandry. Applications of lime-sulphur have repeatedly been noted as ultimately leading to outbreaks of scale insects, due to paralysis of their parasites; and in 1941, cryolite was found to cause such a high mortality among predatory coccinellids that they were incapable of exercising their former control of citrus mealybugs. Both old and modern sprays, designed to combat codling moth, generally result in heavier infestations of red spider and leaf hoppers. These adverse effects can nevertheless be minimized by appropriate choice of the chemical and judicious timing of its application. For example, nicotine dust does little harm to larval coccinellids and syrphids, and arsenicals are relatively innocuous to many parasites and predators. When there is a differential emergence, in time, of hosts and parasites, it is often possible to restrict spraying to periods when the parasites are least vulnerable. Maximum injury to beneficial insects is most likely to result from spraying when they are in maximum abundance, namely, during the later phases of outbreaks.

All these ameliorative measures designed to conserve parasites and predators, and the outcry about adverse effects of insecticides, are based on the assertion that natural enemies have a significant role in suppressing potential pest-populations below the 'level of economic significance'. The words in inverted commas should be noted, because the role of natural enemies (including pathogenic organisms) in eventually effecting the collapse of insect-outbreaks is an entirely different subject. Since the multiplication of parasites and predators is dependent on the density of the host-insect, economic control is feasible only if the host is always present to a density which favours the natural enemies, without causing damage to the food-plant of the host—a finely adjusted interaction indeed. It must be emphasized, also, that mortality attributed to biotic factors is only a part of total mortality, which is the combined result of many factors.

Of the numerous projects which have been launched with the objective of controlling pests by the introduction of parasites and predators, only some twenty have been really successful—and mainly in tropical or semi-tropical regions of the world. Projects for augmentation of native parasites have proved disappointing and costly in relation to the increment of parasitism. Even in countries of an old-established agriculture, where pests and their enemies have had ecological opportunities of attaining relative stability, there is no dearth of pest-outbreaks. A survey of old books and periodicals shows that, even in Britain, crop and stock have suffered intermittently for cen-

turies, and before the use of insecticides was given any consideration. This carries no implication that it is not worth while making the fullest use of all available natural enemies of pests, but simply that they cannot be solely relied upon as permanent controlling agents. Indeed, no less an authority on biological control than Dr. W. R. Thompson makes the following statement: "The discontinuity and variability in habitats, produced by physical factors, both in time and space, is the primary extrinsic factor of natural control".

In view of the repercussions, already outlined, which have followed the application of some of the new chemicals, it is of interest to consider briefly the kind of happenings which may be expected, on theoretical grounds, to follow the operation of any drastic mortality factor in a biological complex of phytophagous insects, predators and parasites. Volterra gave quantitative expression to predator–prey interactions, and has enunciated basic generalizations or 'laws', of which the third is his 'Law of the Disturbance of the Averages'; stating that if two species living together (one feeding on the other) are destroyed in proportion to their numbers, the average number of the prey increases and that of the predator diminishes.

The interesting practical significance of this law is that while an insecticide (or any other highly destructive factor) causes an immediate reduction of the damage, the effect is temporary even in respect of species which are materially suppressed by natural enemies. These are dependent for their increase on the population-density of the host, so that their increase is much slower than that of the host when both population-densities are low. Hence, impoverishment of a natural complex of this kind temporarily releases the host from control, and there follows a series of violent fluctuations in the average density of the host, until the natural enemies re-establish the former relative stability. During this period, before the natural enemies can exercise adequate control, the pest may attain densities of serious economic import.

That such effects occur, sometimes, after application of a potent insecticide, is well exemplified by the resurgence of aphides and red spider, following the application of DDT to fruit-trees; but here the trouble is intensified by the prolonged toxicity of the residues to the notoriously susceptible parasites and predators. This exemplifies an important point concerning the application of insecticides (particularly in respect of those with persistent residues), namely, the risk of encouraging some *other* pest through destruction of its natural enemies, and more so if the second species is not seriously affected itself by the chemical.

When a species that is known to be significantly affected by biotic factors of mortality attains 'pest' status, then the plant doctor is indeed placed in a dilemma. He must either advise the avoidance of insecticides, to give the natural enemies free rein, and warn the grower of some recurrent injury; or else he must advise the judicious use of insecticides, to obtain immediate amelioration of the trouble, and warn the grower about repeating the treatment to avoid more serious injury. The correct course of action can be determined only after gauging the economics of the situation, but with profit-margins becoming increasingly dependent on yield and high-quality produce, the fundamental issue for many growers is: 'Can I afford *not* to spray ?'.

As to the likelihood of disturbing the so-called 'balance of Nature', the majority of biologists realize what Darwin implied even if his choice of the word 'balance' may appear unhappy to a modern physicist. The quasi-equilibrium eventually attained in Nature is not necessarily, however, to the benefit of man. Interference with Nature is generally accepted as unavoidable, if productivity is to be increased. Modern techniques for increasing yields are certainly conducive to increasing 'imbalance', through gross interference with organic Nature; and unfortunately, in tilting the balance favourably in one direction there frequently ensues a series of unforeseen repercussions. The ultimate re-assertion of Nature is unusually well demonstrated in the world of insects.

Surveying the evidence in retrospect, there is no doubt that extensive and indiscriminate use of the new potent and persistent pesticides could bring about serious consequences; not only by disturbing predator–prey and host–parasite interactions, as outlined heretofore, but also by leading to the production of chemical-resistant strains of pests. Even now, on many farms in Illinois, the resistance of house-flies to DDT has become so high that a change-over to other insecticides is considered desirable. In general, the potential dangers of some of the new synthetics would appear to be least when applied to crops under rotation in temperate climates, and greatest when applied to non-rotated crops under tropical conditions.

The latest developments, in the form of systemic insecticides, may provide the plant doctor with a way out of his dilemma. As a result of war-time investigations in Germany, a group of insecticidal compounds were 'discovered' and found to be absorbed by the leaves and roots of plants. Their 'internal' or systemic action is negligible in plants which have stopped growing, however; and a few plants are intolerant. None the less, these systemic insecticides, for example, octamethylpyrophosphoramide, have a remarkable combination of desirable features; being deadly to sap-suckers, relatively non-toxic to beneficial insects, of reasonable persistency in the plant, and harmless to mammals if used in appropriate dilutions. The supreme advantage of an insecticide such as the above is that the natural enemies of the pest are enabled to reinforce the artificial control of the chemical. Incidentally, this decreases the risk of development of resistant strains of the pest. An 'internal' insecticide has also obvious advantages against leaf-miners, stem-borers, root-suckers, and other species which are difficult to control because of their inaccessibility. Further exploration of the uses and limitations of systemic insecticides (and fungicides) is eagerly awaited.

A survey of the situation concerning the new insecticides seemed desirable if for no other reason than to direct attention to the various factors which are involved in natural controlling complexes. Their analysis, involving assessment of the relative significance of mortality factors, has become of considerable urgency so far as insects are concerned, as a direct result of the synthesis of these remarkable new pesticides and their appearance on the market in ever-increasing profusion. The suitability of an insecticide is not merely a question of toxicity and cost—the chemist can tell us about that—it is the ecologist who must be the final adjudicator as to the appropriate uses of these powerful artificial aids to pest control. It would be most unfortunate should they be denigrated through incompetent or over-enthusiastic handling.

LIFE AND WORK IN EXTREME ENVIRONMENTAL CONDITIONS

IT must have been almost without precedent that Section A (Mathematics and Physics) of the British Association should have devoted a session at the recent Edinburgh meeting to so biological a subject as "Life and Work in Extreme Environmental Conditions". The title might have included pressure as well as temperature extremes ; but the former were not considered by any of the speakers, and the morning was devoted entirely to the effects of thermal stress. The study of this subject is not new, for it began two hundred years ago ; but it has been taken up again recently with some intensity, and its importance for industry and the Armed Services can scarcely be over-emphasized. Those who have been frustrated in their attempts to lay in a stock of fuel for the winter of 1951–52 may feel that it has considerable importance for the ordinary citizen.

The president of the Section, Sir David Brunt, was in the chair and the first paper was given by Dr. O. G. Edholm, who pointed out that the subject under discussion must be counted an unusual one since it had brought together physicists, psychologists and physiologists. Had Dr. Edholm realized what the discussion would bring forth, he might have said even more about the widespread interest of the subject. His paper dealt with the basic principles of heat regulation in man. He emphasized the relative constancy of the body temperature and discussed the various ways by which this is maintained. He directed attention to the fact that the various organs produce heat at different rates, and emphasized the overriding effects of exercise and of the ductless glands in varying the amount of heat produced by the body as a whole.

The second paper, by Dr. F. Marsh, was the only one which did not deal with human physiology. The work he described had been done on rabbits at Abadan in the Persian Gulf, where he had studied the effect of raising their temperature by exposing them to the sun. The rabbit loses heat mainly by varying its respiration-rate and the amount of blood flowing through its tongue. Observations were made of the animals' respiration-rate, carbon dioxide output, rectal temperature, heart-rate and venous hæmoglobin. Dr. Marsh did not give any details of the methods he had employed to make these measurements, but his observations showed that after the body temperature had risen to a certain height, which varied from one rabbit to another, there was great danger of collapse and death at any time from then onwards for at least twenty-four hours, even if the animal was cooled to a normal temperature by placing ice on its fur, and if it appeared relatively normal after this had been done. In considering the application of this work to man, the chief conclusion was that prevention is better than cure.

Dr. N. H. Mackworth described work which he had done in an improvised wind tunnel at Fort Churchill in Canada on the effect of cold and wind in destroying touch discrimination in the fingers. This is an important matter where fine work is concerned because gloves destroy a man's manual dexterity. But so do cold and wind, so that to remove the gloves to do the job often leads to unfortunate results. Dr. Mackworth made two points which were no doubt noted by the physicists in his audience. In defining conditions for fine work out of doors, it is not enough merely to give the temperature and wind velocity. The reaction of the man and some way of measuring it are just as important, because, first, no two men are able to withstand extreme conditions equally well, and, secondly, acclimatization and practice can lead to great improvement in the performance of a single man. He illustrated this by showing how much better men accustomed to working out of doors performed in these experiments than those who normally did all their work in warm rooms.

A joint communication by Profs. E. M. Glaser and R. A. McCance dealt with some of the fundamental adjustments by which the temperature of the internal organs is maintained, and they pointed out that in order to achieve this the temperature of the peripheral parts of the body may vary very widely. The temperatures of the skin and limbs are usually lower, but may he higher than the mouth or rectal temperature. They also directed attention to the fact that some variation in the internal temperature is compatible with life and even with comfort, and that after the internal temperature has been raised or lowered by a degree or more it tends to stabilize itself for many hours at or near the new temperature even when the man returns to the original environment. In other words, the body is so organized that it tends to produce a balance between heat gain and heat loss rather than to maintain a fixed internal temperature. In this respect its regulating mechanisms may be compared with the governor of a steam engine rather than the laboratory thermostat which usually operates by cutting in and cutting out as the temperature of the bath varies.

Dr. T. Bedford drew upon his great experience of industrial work to bring out the facts that industrial efficiency depends very much upon the temperature at which the work is done. He showed, for example, that the output from mines is affected in this way and that there are interesting differences between the European miner and coloured workers. A wet-bulb temperature of 84° F. reduces the efficiency and output of European miners very materially, much more so than it does those of coloured people ; this is probably because the European sets himself a relatively much higher standard in a cooler environment. Dr. Bedford produced many other instances of the effects of temperature. In hot industries, for example, the output tends to rise in winter, whereas in cold industries it tends to rise in the summer.

Warp breakages can be reduced by raising the temperature under which cotton is woven ; but in hot humid environments human efficiency falls, so that a mean has to be found at which the man and the cotton thread can both survive. This has been shown to be about 75° F. (dry bulb) and 73° F. (wet bulb). Dr. Bedford concluded by quoting some work of Dr. Mackworth's which has shown that the reception errors of telegraphists rise very rapidly when the external temperature and humidity reach a certain point.

Dr. Ezer Griffiths was the last speaker on the programme. He discussed various ways of measuring temperatures and humidity as they applied to man and pointed out the failings of the kata-thermometer. He then described a mechanical man which has recently been designed and which can measure the heat absorbed by or radiated from itself by using electronic recording. The control panel, which Dr. Griffiths displayed, looked very complicated, although he said it was simple—as no doubt it was, compared with the physiological control panel in the hypothalamus.

Sir David Brunt opened the discussion by saying that he had encouraged the organization of this meeting as he was anxious to know how the environment which he had studied as a meteorologist affects the bodies which the physiologists set out to study. His idea had been to stimulate interest in the climatic conditions under which man ceases to work efficiently and to discover whether physiologists and psychologists are prepared to find out more about this. The lively discussion which followed centred largely upon the word 'comfort'. Miss M. V. Griffiths and others spoke about the advantages of floor heating. It was stated that if the temperature of the floor is 72–75° F. people in the room can be maintained in comfort when the temperature of the room itself is only 54° F., though this was doubted by Dr. Bedford—evidently one of the world's 'cold mortals'. The heating and ventilation of motor buses also came in for some discussion, a matter of some importance to many people to-day. The most satisfactory system seems to apply the heat near the floor and ventilate the bus near the ceiling. Reducing the humidity brought in on wet clothes and inseparable from expired air appears to be a very important matter in bus management because, apart from the comfort of the travellers, it greatly reduces the time which has to be spent by the maintenance staff in sponging down the interiors to keep them clean. Two geographers joined in the discussion and pointed out the importance of work of the kind described at the meeting for anyone who has to study man's place in Nature. Both put in a plea for more work of the same kind and also for meteorological records which could be made the basis of geographical science. At present the material supplied to them by the meteorological services gives no clue as to how a man would react under those conditions. In a final word, Prof. Glaser pointed out that any discussion of comfort must take into account the fact that what is comfortable for *A* is not comfortable for *B*, and that what is uncomfortable for *A* to-day may be quite comfortable for him in a few weeks time when he has become acclimatized. He also pointed out something much more striking, namely, that comfort can be achieved at an internal temperature relatively far removed from the person's 'normal' one; and as a last shot at the reliability of comfort as an index of any value, he directed attention to the fact that the man in a *rigor* from malaria with a rising temperature usually feels most miserably cold.

OBITUARIES

Prof. A. Sommerfeld, For.Mem.R.S.

The death of Prof. Arnold Sommerfeld, at the age of eighty-three, occurred in Munich on April 26, after he had been knocked down by a motor-car.

With Sommerfeld one of the physicists has passed away who helped transform physics from what we now call classical physics to the new or quantum physics. "Quantum Theory is a child of the twentieth century", Sommerfeld was fond of saying, alluding to the fact that Planck introduced the quantum constant h in the theory of black-body radiation in 1900. Much of the rearing of this infant fell to Sommerfeld.

Sommerfeld's main contribution to quantum physics consists not of the fundamental laws or models. To his name there remains attached the fine structure constant and the method of applying quantization to more than one variable; the discovery of selection and intensity rules and thereby the interpretation and classification of a wealth of spectroscopic data in the optical and X-ray region; and the opening up of a new era in the theory of metals by his application of Fermi statistics to the electrons in metals. His main importance lies in his untiring probing into the new methods of atomic physics, by carrying problems to the ultimate test of quantitative agreement between experiment and theory. He was tireless in propounding the new theory at home and abroad in a spirit of optimism and enthusiasm; and no one has done so much for the consolidation of the rapidly developing new physics as he did by the five editions of "Atombau und Spektrallinien" which appeared between 1919 and 1931, each with many chapters re-written and brought up to date. Physicists all over the world have derived great profit from this labour, which seemed scarcely to interrupt the steady flow of research papers of Sommerfeld himself and his numerous pupils.

Sommerfeld was proud that he came from Königsberg, a geographical outpost and spiritual bastion among German universities. His father was a medical man, and the son graduated at the Gymnasium (1886) and University (1891) there. Franz Neumann, then ninety years old, who was the originator of the teaching of theoretical physics as a subject in its own rights and of the seminar method of teaching theoretical subjects, had made Königsberg one of the foremost schools for mathematics and mathematical physics. Sommerfeld's dissertation (under F. Lindemann), on "The Arbitrary Functions in Mathematical Physics", deals with the development of functions according to systems of orthogonal functions. Up to his death Sommerfeld found occasion to enlarge on this first brilliant work of his.

The full power and originality of Sommerfeld's mathematical construction appeared soon after in a series of papers on the diffraction of light by an edge (1894). The advance of this theory over previous ones (Fresnel, Kirchhoff) lies in defining the solution entirely by the differential equation of wave propagation together with the boundary conditions on the opaque half-plane; the method is an ingenious combination of image methods and of Riemannian multiply connected planes. In later years (1911), Sommerfeld extended the method when he discussed the diffraction of X-rays by deep wedge-shaped slits (Walter and Pohl) in papers that led to a reliable value of the then still unknown wave-length of X-rays.

In 1895 Sommerfeld became assistant to Liebisch in the Mineralogical Institute in Göttingen; but soon after he turned to more inspiring work than drawing crystals by becoming assistant to Felix Klein. This great master of mathematical synthesis deeply impressed Sommerfeld. Together they planned and carried out the writing of the four monumental volumes "Theorie des Kreisels" (1897–1910), in which the subject of gyroscopic motion is used as a theme for making evident the manifold connexions between dynamics and a variety of mathematical subjects.

The period in Göttingen ended in 1897, when Sommerfeld was appointed to his first chair, that of mathematics at the Bergakademie in Clausthal in the Harz Mountains, not far from Göttingen. The three years he spent there, newly married, were very happy ones.

His next appointment was the chair of applied mechanics at the Technische Hochschule, Aachen (1900–6). His contact with the engineering school

turned his interest to applied subjects, even although he tackled problems of fundamental importance. The papers of this period, on viscous flow lubrication, on friction, on the beats between generators working on the same grid, are among those to which Sommerfeld liked to look back in a spirit of satisfaction not unlike that of Goethe's Faust when he speaks of the improvements he is bringing to the country by constructing canals and irrigation.

At the same time, the problems of ether physics were occupying Sommerfeld. The proper modes of vibration of a rigid spherical electron was a problem seriously discussed at that time, and Sommerfeld, like others, wrote highly mathematical papers on this subject, of which the last appeared in 1905, the year of the birth of relativity. Of more lasting importance are his studies of the electromagnetic fields which are emitted by the sudden stopping of a cathode ray, the *Bremsstrahlung* or white X-ray radiation according to the hypothesis formulated independently by Stokes, Liénard and Wiechert. This subject was followed up as, through the experiments of Barkla on the polarization of X-rays, more than mere total intensity data became available, and as similar effects were measured for gamma-rays. Later it appeared repeatedly in quantum form in papers by Sommerfeld's pupils.

Meanwhile, Sommerfeld had moved to Munich. It was Röntgen, the mighty man in the philosophical faculty, who insisted that Sommerfeld would be a worthy successor to Boltzmann in this chair that had been vacant for some time. A small but autonomous Institute for Theoretical Physics was connected with the chair. The workshop facilities and a few instruments made it possible to illustrate by simple experiments some of the conclusions arrived at in the theoretical courses. L. Hopf's work on Reynolds's number for flow in an experimental river-bed, and soon Laue, Friedrich and Knipping's discovery of X-ray diffraction by crystals, fully justified the existence of such an institute which had appeared to some as a self-contradiction.

In Munich Sommerfeld soon began to attract students in ever-growing numbers. P. Debye, whom he had brought with him from Aachen as his assistant, shared with Sommerfeld the success of building up a first group of graduate students who were keenly intent on physics and also enjoyed the colourful life which Munich offered by the combination of its natural and artistic climate. Many a problem was raised and discussed in the after-lunch meetings in the Hofgarten Café, between Sommerfeld and his group, the experimentalists from Röntgen's laboratory and those of the Technische Hochschule. These frequent informal meetings of physicists of various degrees of experience were most stimulating, even more so than the official colloquium which took place once a week during term-time.

Sommerfeld's success as a teacher was due to the clear and concrete expression of his ideas, and to the choice of subject in his lectures, which made even the young student realize that behind the domain of established theory there follows a domain of unsolved problems. The research on which he was currently engaged often occurred in preliminary form in Sommerfeld's course lectures ; thus in 1909 the theory of relativity appeared in his electrodynamics course at a time when he was developing the four-dimensional vector form of this theory, and in 1927 the application of Fermi statistics to metals. This made his introduction to physical theory always an exciting experience full of reality. Further, Sommerfeld had a keen appreciation of intellectual capacity and real endeavour at whatever stage it appeared, and he was a friend, not only a teacher, to his students. He took them home and made them perform, or listen to, music or reading. In winter, skiing expeditions would be organized during week-ends or in the Easter vacations. On such occasions a long line of physicists might be seen making their way up the snowy slopes, and a panting discussion might be heard through the clean cold air of recent or future experiments and theories.

Among the problems of applied physics to which Sommerfeld and his pupils made essential contributions, that of the propagation of electric waves along the surface between two media stands foremost. His student days had been marked by the impact of Hertz's experiments on the theory of electromagnetism. In 1898 he gave a quantitative theory of Hertz's results on waves along wires ; in 1911 his pupil Hondros discussed waves of all types travelling along dielectric rods. Starting in 1909, a series of papers dealt with the propagation of radio waves along an earth assumed flat or spherical, and with the directed action of horizontal antennæ (v. Hoerschelmann). Many years later, Sommerfeld gave a condensed account of this group of papers in Franck and Mises' book on partial differential equations in physics.

Regarding Sommerfeld's contributions to the development of atomic theory, the account can be short, because this is so much more recent work that it is still firmly imbedded in the memory of university teachers in many countries, who are handing on to the new generation their own personal impressions of Sommerfeld and his work, which they gained either at his school or in the course of his extended visits to other universities (Spain, 1922 ; United States, 1922–3 ; England, 1926 ; India, Japan, California, 1928–29 ; Volga congress, 1930 ; Ann Arbor, 1931). Sommerfeld's book "Atombau und Spektrallinien" has been, from 1919 on, an unfailing guide through the rapidly accumulating volume of atomic theory. In 1929 it was supplemented by the "Wellenmechanischer Ergänzungsband", which, some years later, was converted into a full-fledged companion volume "Wellenmechanik" (3rd edit., 1944). With the advent of wave-mechanics, theoretical atomic physics returned to the type of eigenvalue problems which had been Sommerfeld's favourite field from his early days on. No wonder that he impressed his personal stamp on the account of the new subject.

Among the major decisions in Sommerfeld's life were the refusals to accept the chairs of theoretical physics in Vienna (1917) and in Berlin (1927). He retired from the Munich chair in 1935, but continued intensive scientific activity up to the very last. The six volumes of "Vorlesungen über theoretische Physik" (the last of which is being prepared for publication) are, as he wrote, a bequest to the young generation ; their preparation enabled him to survive the political chaos during his years of retirement. It is hard to believe that so vigorous and in many ways novel an account of classical physics should have been written by a man nearing, or even surpassing, his eightieth year. Two of the volumes have appeared in English translation, and the others are to follow shortly.

With his long list of scientific papers and his monumental books on atomic theory and on classical physics, Sommerfeld will always be regarded as an

imposing figure standing on the threshold between two periods in the history of physics. As long as his pupils live, they will bear an affectionate memory of a great teacher and unselfish friend.

P. P. Ewald

Mr. Lincoln Ellsworth

Lincoln Ellsworth, whose death took place at the end of May, was one of the pioneers of polar flying, both in the Arctic and the Antarctic. He was born in Chicago in 1880 and was employed for several years on survey work on Canadian railways, and also as an assistant engineer on goldfields in Alaska. During the First World War he was in the U.S. Army Air Corps.

Ellsworth first became known to a wider public in 1925, when his father decided to finance a flight which Roald Amundsen was planning to make to the north pole in Dornier-Wal flying boats. When near the pole it was found necessary to land on a lead of open water in the polar pack. The take-off, however, proved extremely difficult. One of the flying boats was abandoned, and it was three weeks before the other was again airborne and able to return to Spitsbergen from a farthest north latitude of 78° 44′.

Next year Ellsworth again collaborated with Amundsen, who was negotiating for the purchase of an Italian airship, renamed the *Norge*. Nobile was the technical expert, Amundsen provided the polar knowledge, and much of the financing again came from Ellsworth. The expedition was entirely successful. It took off from Kings Bay, Spitsbergen, on June 11, 1926, and after crossing the north pole landed at Teller in Alaska three days later.

Ellsworth's next effort was to assist Sir Hubert Wilkins in plans for a voyage in 1931 from Spitsbergen northwards under the pack-ice in the submarine *Nautilus*. He did not himself take part in the expedition, but was one of the party that same summer on the airship *Graf Zeppelin* on her Arctic voyage from Friedrichshafen over Franz Josef Land and Severnaya Zemlya (Nicholas II Land).

This first contact with Wilkins was the beginning of a long and intimate association, and Ellsworth now turned his attention to the Antarctic, with Wilkins as his adjutant. His first attempts, however, in 1933–34 at the Bay of Whales in the Ross Sea, and in 1934–35 from Snow Hill on the east coast of Graham Land, were unsuccessful; but next year, with Hollick-Kenyon as pilot in a Northrup machine, the *Polar Star*, a flight was made from Dundee Island on the north-east coast of Graham Land across Antarctica to the Ross Sea. No less than three landings were made, and the flight, which had begun on November 23, 1935, ended on December 4, when the machine landed on the Ross Barrier some miles inland from the Bay of Whales. Ellsworth's radio had failed at an early stage in the flight, and in view of the uncertainty arising the British, Australian and New Zealand Governments in collaboration decided to divert *Discovery II* from her usual oceanographical work. She arrived at the Bay of Whales on January 15 and rescued Ellsworth and his companion, who had been living in an ice cave for six weeks. This flight was the most successful yet made in the Antarctic, and the three landings to wait until the weather improved were a completely new departure in polar flying, representing a striking advance from Ellsworth's flying boat experience in 1925.

After his trans-continental flight, Ellsworth made one more expedition to the south, in 1938–39, when a flight was made over Princess Elizabeth Land at 12,000 ft. along the 79th meridian to 72° S. On his return, Ellsworth sold his ship *Wyatt Earp* to the Australian Government, having by now seen polar flying develop from the first uncertain stages to his own successful flight across the Antarctic continent.

J. M. Wordie

Miss V. E. Beneš

Vlasta Eva Benešova was born in Kutna Hora, Bohemia, on December 2, 1919. She studied at the Lycée at Kolin and was a distinguished student in the Pharmaceutical Department of the University of Prague. After holding various provincial appointments she returned to Prague and began to carry out research work on "La sedimentation des Algues", under Prof. Silvestr Prat. In 1947, with the aid of a bursary, she proceeded to Paris and continued her research at the Sorbonne under Prof. W. Plantefol. She published three papers in the *Comptes rendus* of the Paris Academy of Sciences in 1948 and 1949, her work on *Hæmatococcus pluvialis* being an important contribution to our knowledge of the Volvocales. Afterwards, fired with enthusiasm by a visit to the marine station at Roscoff, she began a serious study of the marine algæ, under Prof. J. Feldmann and M. Chadefoud. In 1949 she sailed for Australia, where she collected marine algæ extensively on the coasts of New South Wales and made an intensive search for members of the Ceramiales with the view of a detailed study of their life-cycles. Despite her language difficulty she taught easily, and Prof. Burges writes of the active and successful contribution that she made to the study of the algæ in the University of Sydney. Towards the close of 1950, in a serious fall in the laboratory, she fractured her pelvis; but she made a good recovery and returned again to collect on the shores of New South Wales, a locality for which she had developed a deep regard. Perhaps it was too soon for her to venture alone on reefs as difficult as those near the Woy Woy Research Station, for to the dismay of her friends, on March 10 she did not return from the collecting ground.

Prof. Feldmann writes: "Sa tragique disparition qui est venue si soudainement interrompre sa carrière, constitue une perte sensible pour l'Algologie. Mais le souvenir de Vlasta demeurera surtout vivace dans le cœur de ceux qui l'ont connu et ont pu apprecier ses qualités d'esprit et de cœur." Lily Newton

We regret to announce the following deaths:

Prof. J. W. Bigger, during 1924–50 professor of bacteriology and preventive medicine in the University of Dublin, aged fifty-nine.

Harald Blegvad, secretary-general of the International Council for the Exploration of the Sea, on August 22, aged sixty-five.

Brigadier E. M. Jack, C.B., C.M.G., director-general during 1922–30 of the Ordnance Survey, on August 10, aged seventy-eight.

Dr. John R. Loofbourow, associate professor in the Massachusetts Institute of Technology, known for his work on absorption spectroscopy and the biological effects of radiation, on January 23, aged forty-seven.

NEWS and VIEWS

National Science Foundation : Dr. Harry C. Kelly

THE second of the technical divisions of the National Science Foundation, 901 16th Street, N.W., Washington, D.C., has been established with the appointment of Dr. Harry C. Kelly as assistant director for the Division of Scientific Personnel and Education. The Division of Biological Sciences was the first of the four statutory divisions to be established. The Division of Scientific Personnel and Education will be responsible for the development and administration of programmes relating to the granting of scholarships and fellowships by the Foundation in the mathematical, physical, biological, engineering, and other sciences. Until recently, Dr. Kelly was head of the Scientific Section of the Office of Naval Research Branch Office in Chicago. Previously he was chief of the Scientific and Technical Division which advised General Douglas MacArthur on the development of a scientific and technical programme for Japan. Under his leadership, Japanese scientific men elected a representative body to reorganize and rehabilitate their national bodies of science. These activities led to a new Science Council, democratically elected by qualified men of science.

Nuffield Foundation Grants to the University of Cambridge

THE Nuffield Foundation has made a grant of £25,000 over a period of five years for the development of calculating machines in the Mathematical Laboratory, University of Cambridge, under the direction of Mr. M. V. Wilkes. This Laboratory has already built a high-speed electronic calculating machine (the Edsac) and applied it in a number of fields of scientific research. It has become evident that there are many opportunities in Cambridge for such applications, and the present machine is already overloaded. The Foundation's grant is to be used for the construction of a new machine, which will be more reliable than the present one, slightly faster, contain more storage capacity and be able to handle a much larger quantity of work. The general design of the new machine is already clear and a certain amount of preliminary work has been undertaken. The Foundation has also made a grant of £5,000 over a period of five years for the support of "theoretical studies in biochemistry" to be carried out in the Chemical Laboratory under the direction of Sir John Lennard-Jones. Of this grant £4,400 is to be used for the salary of a senior assistant, whose duties will be to pursue research in subjects likely to be of value in biochemistry and to supervise the work of research students in the same field, and the remaining £600 for incidental expenses. The programme of work is the outcome of recent studies in Sir John Lennard-Jones's Department, the immediate purpose of which was to discover the principal factors which determine the shapes of molecules. This has led to the new views of the significance of 'lone pairs' of electrons, and of the so-called 'hydrogen bond' or the 'hydrogen bridge' of molecules of biological interest. Theory alone cannot be expected to unravel the problems of complex molecules such as proteins, but it may help in choosing between some of the models which have been proposed. These, and other similar problems, require for their solution not only experts in biochemistry, chemistry and physics, but also others with a good training in mathematics and theoretical chemistry.

The Peckham Health Centre

IT is with regret that we note the closing down of the Peckham Health Centre. In a statement prepared by the directors of this pioneer health centre they indicate that an approach to the Ministry of Health disclosed that in principle Peckham was deemed to be contrary to the policy of the Ministry. It could not receive support from the Health Act because it could not be fitted into the existing administrative scheme for the following reasons : the health centre has been concerned exclusively with the study and cultivation of health and not with the treatment of diseases ; it is based exclusively on the integrated family and not on the individual ; it is based on a "locality" and has no "open" doors ; the basis is contributory and not free. The directors also state that Peckham has been based on autonomous administration and so does not conform to the lines of administration laid down by the Ministry. Moreover, Peckham arises out of an original conception which extends into a region beyond the ambit of present-day medicine and hygiene and so is not eligible to receive the enabling stamp of authority. The building has now passed into the control of the London County Council, which proposes to use it for other purposes.

Mechanism and Evaluation of Antiseptics

A CONFERENCE which meets to discuss the mechanism and evaluation of antiseptics must necessarily cover a wide field, and this is evident in the eighteen papers to be found in "Mechanism and Evaluation of Antiseptics" (*Ann. New York Acad. Sci.*, **53**, Art. 1, 219 ; 1950 ; 3 dollars), which prints the papers given at a conference held in 1949. It is impossible in a short space to indicate the contents of so many papers ; they discuss streptomycin and other antibiotics, the procedure of paper-disk assay, the meaning of bacteriostasis, bactericidal effect and rate of disinfection, the interaction of surface-active agents and proteins, the role of antagonisms in the evaluation of antiseptics, present trends in the methods of testing antiseptics, the mode of action of halogens, and kindred subjects. The bibliographies attached to each paper extend the usefulness of a volume which will interest everyone concerned with the control of injurious organisms.

Foremanship Training in Technical Colleges

ON all sides of industry there is evidence of the increasing recognition of the vital role of the foreman in modern management. Broader study of the job, improved selection, and extensive training schemes are developments which are now prominent features in many industrial organizations. Yet there are still large areas where little has been done, and this problem has recently been considered by the British Institute of Management. A sub-committee was set up which, in its report, suggests practical ways in which technical colleges may give immediate help in the training of foremen ; its recommendations are based on comprehensive evidence of the needs of industry and modern methods of meeting them. The sub-committee indicates that it is only concerned with short-term programmes designed to appeal to

the established foreman and that, though such brief courses may be a useful introduction, they are no substitute for progressive long-term training within industry and outside. No recommendations were made about the means of training potential foremen or the contribution of the technical colleges to the long-term training arrangements of the small firms, and these are matters deserving further and urgent study. Copies of the report may be obtained from the British Institute of Management, 8 Hill Street, London, W.1.

Society for the Bibliography of Natural History

Instituted for the study of the bibliography of all branches of zoology, botany and geology, the most recent issue of the *Journal of the Society for the Bibliography of Natural History* contains a detailed list of the published writings of C. J. Maynard (1845–1929) by Charles Foster Batchelder (2, No. 7; Jan. 1951). Maynard spent most of his life on a small farm at Newton, Massachusetts. He had little formal education and at first worked on the family farm. Soon he took up taxidermy, and through this managed to eke out a frugal existence while making valuable contributions to knowledge of the natural history of his birthplace and two districts which he visited frequently—Florida and the Bahamas. Altogether Maynard published more than 250 books and papers, many of them bearing the imprint of a very unconventional and original man. With some of his more important works Maynard took pride in setting the type, making wood-cuts, drawing lithographs and doing all the press work himself. He also issued price lists of natural history specimens which he had for sale, and, much to the horror of many orthodox taxonomists, more than once chose such lists to describe new species.

Radio Communication and Radio Measuring Instruments Committee

A joint Committee, to be known as the Joint Advisory Committee on Radio Communication and Radar Measuring Instruments, has been set up from representatives of three trade associations—the Radio Communication and Electronic Engineering Association, the Radio and Electronic Component Manufacturers Federation and the Scientific Instrument Manufacturers Association. The Committee is open to all members of these associations; it is not itself, however, a trade association, but rather an advisory body for all matters relating to the development and production of radio-communication and radar-measuring instruments. In particular, it is expected that the provision of this single channel for consultation with Government departments on matters of common interest in this field of measuring instruments will prove convenient both to the industry and to the departments. The secretary of the Committee is the assistant secretary of the Radio Communication and Electronic Engineering Association, which is at 59 Russell Square, London, W.C.1.

International Congress on Analytical Chemistry, 1952

Further details are now available concerning the arrangements for the International Congress on Analytical Chemistry which is to be held in Great Britain next year. The Congress will meet at Oxford during September 4–9. Papers will be issued in advance of the meeting and the contributors will give only a brief summary of their papers, most of the time being given over to discussion. Arrangements have been made to publish the whole of the proceedings in a special number, or numbers, of *The Analyst* as soon as possible after the Congress. During the Congress it is proposed to have in operation working demonstrations illustrating new techniques or special applications of older techniques in analytical chemistry. In addition to this, and quite separate from it, there will be a trade exhibition comprising apparatus and books. This exhibition will be under the management of Mr. W. Thompson, of the Imperial College of Science and Technology, London, S.W.7. The honorary secretary of the Congress is Mr. R. C. Chirnside, Research Laboratories, General Electric Co., Ltd., Wembley.

Colonial Service: Recent Appointments

The following appointments in the Colonial Service have recently been announced: S. M. Taylor (agricultural officer, Sierra Leone), director of commerce and industry, Sierra Leone; A. E. Trotman (director of agriculture, Jamaica), member for agriculture and natural resources, Tanganyika; J. J. Lawrie (assistant conservator of forests, Gold Coast), assistant conservator of forests, Somaliland Protectorate; W. D. Burrowes (agricultural economist, Jamaica), senior agricultural economist, Jamaica; L. A. Powell (agricultural officer, Jamaica), senior agricultural officer, Jamaica; D. N. Smalley (senior agricultural assistant, Nyasaland), principal agricultural assistant, Nyasaland; G. Moore, agricultural officer, Gold Coast; G. P. Leedal, geologist, Tanganyika; G. F. Burnett, scientific officer (entomologist), Colonial Insecticides Research Unit, Tanganyika; J. F. Garden, veterinary officer, Tanganyika; R. C. Nixon, veterinary officer, Tanganyika; G. Y. Benzies, assistant meteorologist, Nigeria; J. F. Fisher, meteorological officer, Nyasaland; E. H. Holland, veterinary officer, North Borneo; M. A. Prentice, entomologist, Uganda.

City and Guilds of London Institute

Mr. J. W. Voelcker has been appointed secretary of the City and Guilds of London Institute for the Advancement of Technical Education in succession to Mr. G. C. Stephenson, who has retired, but who will continue to help and advise in the work of the Institute. Mr. Stephenson has been secretary of the Institute since 1924. Mr. Voelcker studied electrical engineering during 1920–22 at the City and Guilds College, and then he went to the Massachusetts Institute of Technology. He joined the English Electric Co., Ltd., in 1925. Mr. Voelcker is the general editor of *The Central*, the journal of old students of the City and Guilds and Finsbury Technical Colleges, and president of the M.I.T. Club of Great Britain.

University of London: Appointments

The following appointments in the University of London have been announced: Mr. W. B. Emery, to the Edwards chair of Egyptology tenable at University College, from October 1, or as soon after as possible; Dr. E. Glaister, to the University readership in mechanical engineering tenable at the Imperial College of Science and Technology, from October 1; Mr. T. W. Hutchison, and Mr. R. Turvey, to University readerships in economics tenable at the London School of Economics and Political

Science, from October 1. The title of professor of veterinary anatomy in the University has been conferred on Mr. James McCunn, in respect of the post held by him at the Royal Veterinary College.

The Night Sky in September

NEW moon occurs on Sept. 1d. 12h. 49m. U.T., and full moon on Sept. 15d. 12h. 38m. The following conjunctions with the moon take place: Sept. 3d. 13h., Saturn 5° N.; Sept. 17d. 02h., Jupiter 5° S.; Sept. 27d. 21h., Mars 0·02° S.; Sept. 28d. 05h., Venus 7° S. In addition to these conjunctions with the moon, Mercury is in conjunction with Venus on Sept. 12d. 13h., Mercury being 8·3° N. Mercury is too close to the sun during the early part of September to be seen; at the middle and end of the month it rises at 4h. and 5h. respectively, and may be seen for a short period before it is lost in the sunlight. Venus is in inferior conjunction on Sept. 3, but later in the month can be seen in the morning hours, rising at 4h. 05m., and 3h. 10m., on Sept. 15 and 30, respectively. The crescent form of the planet is easily seen with small optical aid and the stellar magnitude varies between −3·3 and −4·2 during the month. Mars, a morning star, rises about 2h. 15m. throughout September; towards the end of the month the planet is very close to α Leonis. Jupiter rises at 19h. 55m., 19h., and 17h. 55m., at the beginning, middle and end of the month, respectively, stellar magnitude −2·5. Saturn is in conjunction with the sun on Sept. 29 and is too close to the sun during the month for favourable observation. Autumnal equinox occurs on Sept. 23d. 21h. Occultations of stars brighter than magnitude 6 are as follows: Sept. 13d. 19h. 23·6m., ι Aquar. (*D*); Sept. 22d. 23h. 49·2m., 136 Taur. (*D*); Sept. 23d. 0h. 16·2m., 136 Taur. (*R*). (*D*) and (*R*) refer to disappearance and reappearance, respectively, and the times refer to observations made at Greenwich. On Sept. 1 an annular eclipse of the sun takes place and is visible as a partial eclipse at Greenwich, where it begins at 11h. 20m. and ends at 12h. 53m. The magnitude of the eclipse at Greenwich is 0·16, and the greatest phase is attained at 12h. 07m.

Announcements

LIEUT.-GENERAL SIR FREDERICK MORGAN has been appointed Controller of Atomic Energy in succession to Lord Portall of Hungerford.

MR. VERNON HARBORD, a consulting metallurgist and a partner of the firm of Messrs. Riley, Harbord and Law, has been elected president of the Institution of Mining and Metallurgy for the session 1952–53. Mr. Harbord is a past student of the Royal School of Mines. During the Second World War he was a metallurgical adviser to the Armament Research Department. He has served on the council of the Institution since 1940, being vice-president during 1947–50.

THE seventh Dalton Lecture will be delivered by Lord McGowan in the Manchester Town Hall on September 27, at 7 p.m. Lord McGowan will speak on "A Hundred Years of Chemistry". The lecture is open to the public, but admission is by ticket, obtainable free from the Honorary Secretary, Arthur Carroll, 9 Central Avenue, Sale, Manchester. Supporting the 1951 Dalton Lecture, there will be an exhibition illustrating the progress of chemistry on September 27 (10 a.m.–9.30 p.m.) and September 28 (10 a.m.–8.30 p.m.) in the Gas Showrooms Basement, Town Hall Extensions, Mount Street, Manchester. Admission is free.

A CONFERENCE on "The Rheology of Films and Surfaces" has been arranged by the British Society of Rheology, jointly with the local branch of the Chemical Society, at the Washington Singer Laboratories, University College, Exeter, and will be held during September 27–29. Further particulars can be obtained from the honorary secretary of the British Society of Rheology, Dr. E. W. J. Mardles, Royal Aircraft Establishment, Farnborough, Hants.

THE Second International Congress on Astronautics is to be held in the Caxton Hall, London, S.W.1, during September 3–8. The Congress will be in two parts, the first (September 3–5) being for delegates only, when the business discussed will include the inauguration of an International Astronautical Federation. The second part (September 6–7) will be open to the public, and will consist of the presentation of technical papers. Further particulars can be obtained from the Secretary of the British Inter-planetary Society, 157 Friary Road, London, S.E.15.

THE ninth annual meeting of the Electron Microscope Society of America will be held in the Franklin Institute, Philadelphia, Pennsylvania, during November 8–10. Besides contributed papers, and an exhibit of electron micrographs and commercial exhibits, there will be a symposium on "Elementary Electron Optics and Factors effecting the Electron Microscopical Image". Programmes and abstracts will be available from T. G. Rochow, American Cyanamid Company, Stamford, Connecticut; information regarding local arrangements can be obtained from D. D. Pendleton, Radio Corporation of America, Camden 2, New Jersey.

A JOINT meeting lasting about a week of Commissions 2 (Soil Chemistry) and 4 (Soil Fertility and Plant Nutrition) of the International Society of Soil Science will be held in Ireland in 1952, probably during July. The main purpose of this meeting will be to examine and discuss the application of soil science to the solution of farming problems through the medium of soil analysis, field experiments and other branches of soil research. All papers will be printed in advance, and those desiring to submit papers are requested to consider preparing them in the near future. All communications should be addressed to the secretary of the Department of Agriculture, Dublin, and marked 'International Society of Soil Science Meeting'.

THE eleventh series of postgraduate lectures organized by the Oil and Colour Chemists' Association will be given by Dr. H. W. Thompson, of the University of Oxford, in the Lecture Theatre of the Royal Institution, 21 Albemarle Street, London, W.1, at 6.30 p.m., on October 11, 18 and 25. Dr. Thompson will speak on "Molecular Dynamics and Chemicals Problems". The lectures are open to all on payment of a fee of 10s.; application should be made to the general secretary of the Oil and Colour Chemists' Association, Memorial Hall, Farringdon Street, London, E.C.4.

CURRENT TRENDS IN OCCUPATIONAL PSYCHOLOGY

A DISCUSSION on "Current Trends in Occupational Psychology" occupied the morning session on August 10 of Section J (Psychology) of the British Association. The first contributor was Dr. C. B. Frisby, director of the National Institute of Industrial Psychology. Dr. Frisby began by tracing the development of industrial psychology in Britain during the past thirty years. For most of this period, emphasis had been laid on the investigation of capacities rather than inclinations, and on the use of laboratory methods of inquiry. The Hawthorne studies, and fuller employment, had then caused attention to become focused on conditions affecting motivation at work. In consequence, the industrial psychologist had had to devote more of his time to field investigations; and these had produced new methodological problems.

Dr. Frisby illustrated his contentions by references to three post-war inquiries carried out by the National Institute of Industrial Psychology. One was into joint consultation. It was a study of current practice, and an attempt to identify factors apparently associated with successful joint consultation. The second was designed chiefly to survey current practice in regard to the status, selection and training of supervisors in industry; but was aimed in addition at the improvement of existing selection and training procedures. The object of the third investigation was to discover principles governing the determination of optimum units of work in repetitive tasks that had been greatly subdivided. "It is clear that at some point in the breaking-down process, for a variety of reasons, the operative will become less effective than he was with the larger task. The problem was how to give some guidance to the production engineer in identifying this point."

All three investigations demonstrated the need for sound means of assessing attitudes to work and satisfactions derived from working conditions; and a basic methodological problem was that of finding ways of doing this which would be adequate and acceptable but not time-consuming. Dr. Frisby said that attitude scales have possibilities that should be more thoroughly explored in Britain; but that the interview is usually to be preferred, and interviewing skill is of great importance to the industrial psychologist. Other problems thrown up by the three researches centred on consideration of criteria of occupational success, the most difficult—and perhaps the most important—of all the tasks facing the occupational psychologist.

Dr. N. A. B. Wilson, senior psychologist to the Admiralty, read a paper—part of which was heard by H.R.H. the Duke of Edinburgh—on "Applications of Psychology in the Defence Departments". Psychologists, he said, can scarcely be expected to abolish war. So far, with the possible exception of a few psychiatrists, they have not even proved very good at what is called psychological warfare, which is the art of winning wars without actually fighting, or basic warriorship. The activities of psychologists in the Defence Departments can, in fact, be grouped under two main headings: fitting the man to the job, and fitting the job to the man. In the first group are to be found problems arising in the improvement of methods of personnel selection, methods of training and examining (for example, aircraft pilots), and documentation (for example, at recruiting centres). In the second are problems arising in the improvement of methods of work (for example, gun drills), design and layout of equipment (such as aircraft cockpits), and living and working conditions (for example, operating conditions in extremes of climate). In the Admiralty, the Naval Motion Study Unit, which is the joint responsibility of the Director of Operational Research and the Senior Psychologist, has made proposals that would reduce by two the size of a gun-crew. The psychologist's contributions in this field were of two kinds. He advised on the design of experiments and on the criteria needed in the evaluation of proposed changes; and he advised on the needs and capacities of operators of equipment. His aim was to help to ensure that all drills and equipment prepared for Service use show the maximum possible adaptation to the needs and capacities of all probable users in all probable operational circumstances.

Dr. Wilson commented on five topics that seem likely to provide much work for military psychologists. First, man-power planning in terms of quality is now becoming possible. Given the composition of a naval entry in terms of classification test scores, and given a fairly stable connexion between those scores and advancement, useful estimates can be made of the petty officer material—judged by present standards—likely to be available in a few years time. Secondly, more consideration is being given to the utilization of marginal groups, including the very able or unusually qualified; the dull; the physically substandard; 'high-grade funnies'; and the unstable. Thirdly, within the Services there are many organizational arrangements that would repay investigation in the light of what we now know about human abilities and interests. Fourthly, the educative function of Service psychologists should be developed. For example, they could profitably make better known the advantages of 'over-learning' skills and providing trainees with knowledge of their own progress in training; and of the proper co-ordination of control adjustments with related display changes in equipment design. There is also a need for the further *ad hoc* training of personnel selection officers to give day-to-day advice on matters, falling within their sphere, which the Service psychologists have no opportunity of considering, and for the provision of information, for the ordinary man in the tank or ship or aircraft, on the uses of applied psychology in warfare. Fifthly, it is becoming evident that there is a place for the discreet use of attitude and opinion surveys in the personnel work of the Services. Dr. Wilson concluded his paper, which was very well received, by directing attention to the need of the Services for psychologists who are competent theoretical men and methodologists.

A paper prepared by Dr. E. Anstey, head of the Civil Service Commission Research Unit, on "Applications of Psychology in the Civil Departments", was read by Mr. D. McMahon. It was concerned chiefly with the work of psychologists employed by the Civil Service Commission, either on the Civil Service Selection Board or in the Research Unit; but towards its close, passing reference was made to the

place of psychologists on the Prison Commission and elsewhere.

Psychologists have made three distinctive contributions to the Civil Service Selection Board: first, in the planning of the work of the Board; secondly, in bringing to its activities a certain quality of expert knowledge in the scientific study of personality; and thirdly, in insisting from the outset on the need for a well-designed follow-up scheme, from which an objective judgment of the value of the board's procedures could be obtained. The last of these contributions, Dr. Anstey believes, is the most important; and the outcome will be a series of reports, the first of which has already appeared.

The main activities of the Research Unit have been job analysis, test construction and follow-up. The follow-up has included an inquiry into the progress of a hundred entrants to the Administrative Class who, being already employed in the Civil Service, did not go through the Civil Service Selection Board procedure. They had been given instead a more conventional written examination and board interview, though the board interview had been preceded by a private interview. The whole selection procedure had proved satisfactorily valid, when judged two years later by an overall grading of present performance; and the written examination alone had been found to have made a very useful contribution.

Dr. Anstey thinks that the time is ripe for psychologists in the Civil Service Commission to devote more time to discovering how to get the best out of people who have been selected. The incentives problem is of even greater importance in the Civil Service than in private industry. He wants to see more research done on the size and internal organization of the 'working group'; and on what he calls 'internal incentives', which would help individuals to make regular self-assessments of the quality and quantity of their work. He urged psychologists in the Civil departments to be clear in their own minds about the worthwhileness of their research projects before embarking on them; to make their reports intelligible to non-technical readers; and to aim at striking a satisfactory balance between a high professional standard and practical effectiveness.

Mr. Alec Rodger, reader in psychology at Birkbeck College, University of London, and consulting psychologist to the Admiralty and to the Central Youth Employment Executive, contributed a paper on "Vocational Guidance in Britain", in which he reviewed the past and present work of psychologists in this field and outlined several urgent problems. Conditions for research and development are now more favourable than they have ever been before, partly because the increasing need for the proper use of human resources in industry has directed attention to the advantages of sound guidance. This is shown in the new orientation of the Youth Employment Service and in the work of the Ministry of Labour's Industrial Rehabilitation Units: in both, psychologists have a small but important place.

The most pressing need of all, Mr. Rodger said, is for the clarification of our concepts of occupational success and failure, for without this we shall continue to lack satisfactory criteria whereby to judge the worth of much of our other scientific and technological work. A second need is for better ways of studying the 'requirements' of occupations. Here we have been too long content with the listing of ill-defined qualities that have been considered, on the basis of 'hunch', to be important. Empirical investigation is wanted, and it may well be founded provisionally on the notion that the best way to arrive at satisfactory conclusions about the requirements of an occupation is to study people who are acknowledged failures in it, and to compare them with people who are acknowledged successes. Thirdly, there is a need for a better functional classification of occupations. The conventional grouping of them, as concerned with ideas or things or people, is inadequate.

These papers seem to indicate clearly that occupational psychologists in Britain are in considerably better intellectual health than they were in the years immediately before the War. In research and development alike, they are making substantial strides in industry and in the Service and Civil departments. The work of the Service departments is perhaps particularly impressive in its range and quality. The papers read at this discussion are to be published in book form by Messrs Methuen and Co., Ltd.

TREND OF INORGANIC AND PHYSICAL CHEMISTRY SINCE 1850*

THE development of inorganic and physical chemistry during the past hundred years falls into two periods. Until the end of the nineteenth century these two branches of chemistry experienced a steady evolution, while their theoretical foundations, laid at the beginning of modern chemistry, remained unaltered; but about 1900 a revolution set in which changed these very foundations. The difference is as great as the contrast between the quiet security and constant progress of the Victorian age and the upheaval caused in this century by the two World Wars.

One of the greatest achievements during the first period was the discovery of the Periodic Law; it was based on Lavoisier's conception of the chemical element and on the atomic theory founded by Higgins and Dalton. No explanation for the Periodic Law could be given, and fantastic representations without scientific meaning were common; some unfortunate examples of this attitude can still be seen in the science exhibitions of London's Festival of Britain. A real understanding of the Periodic System only became possible after insight into the structure of matter had been gained, mainly as a consequence of the study of radioactive elements and their radiations. Radium was discovered by Pierre and Marie Curie in 1898, the theory of radioactive disintegrations developed by Rutherford and Soddy in 1902. From this work and from the discovery of isotopy in 1913 by Soddy, J. J. Thomson and Aston, three very important facts emerged which were in contradiction with the doctrines of classical chemistry: (1) elements are not immutable; (2) atoms are complicated structures containing a tremendous store of energy; (3) atomic weights are not fundamental constants. The recognition of these facts, and great strides made during the same period in experimental and theoretical physics, made it possible for Rutherford and Bohr to crown the old atomic theory by a theory of the atom. According to this theory the chemical character of

* Substance of a paper by Prof. F. A. Paneth, F.R.S., read on August 9 before Section B of the British Association meeting at Edinburgh.

an atom is determined primarily by the electric charge of the nucleus, not by its weight; atoms of different weight may belong to the same chemical element (isotopes), and atoms of the same weight to different elements (isobars). In this respect modern chemistry is nearer to Higgins's views than to the narrower ones of Dalton.

The advances made in the understanding of the nature of chemical atoms and of their mutual relationship were not only of theoretical interest. The study of the naturally occurring radioactive substances was followed by the artificial disruption of stable atoms, by the production of radioactive isotopes of inactive elements, and—most spectacular of all—by the creation of no less than nine chemical elements which are not to be found on our earth and of which one, plutonium, is the most important source of atomic energy.

The theory of the atom was also able to shed light on the question of chemical forces; in classical chemistry they were considered as something quite different from the forces dealt with in physics, and scarcely capable of further explanation. As atoms are now known to be structures built up of electrically charged particles, the combination of atoms to molecules is to be understood as the consequence of electric forces. All valency bonds are essentially electrostatic in nature, although the mechanism of interaction is different in the two cases of electro-valency and covalency. The exact mathematical treatment is difficult except in the simplest cases, but the possibility of explaining, in principle, all the so-called chemical forces by the laws known to physics can no longer be doubted.

The theory of chemistry is now a part of physics; but it must not be forgotten that many of the greatest advances in physics have been made on the basis of chemical discoveries. It is safe to predict that for a long time to come the deductive methods of theoretical physics will be supplemented by the inductive approach of the chemist.

IMPROVEMENTS IN CATHODE-RAY TUBE STORAGE: APPLICATION TO A PARALLEL TYPE OF DIGITAL COMPUTER

By G. H. PERRY

Telecommunications Research Establishment, Great Malvern

IN recent publications[1–4], Prof. F. C. Williams and Dr. T. Kilburn describe a storage system for use with binary digital computers, using electrostatic charges on the fluorescent screen of a cathode-ray tube. In these papers, three possible forms of charge distribution are described, each having two states to represent the binary digits nought and one. These have been named: (*a*) dot–dash; (*b*) defocus–focus; (*c*) anticipation. The first of these has been described in detail and has been put into operation in the serial computer in the University of Manchester. In a parallel-operated computer all the digits of a number are used simultaneously, and hence its storage requirements are different from those in a serial machine.

Suppose we have a serial machine using n cathode-ray tubes; a number, of n digits, is stored at n points of a single line on a tube which is scanned serially. Adjacent lines store different numbers. If there are also n lines, and one number is required continuously in a computation, then its line will be regenerated n times compared with its neighbour, and this ratio will determine interaction and consequent spacing.

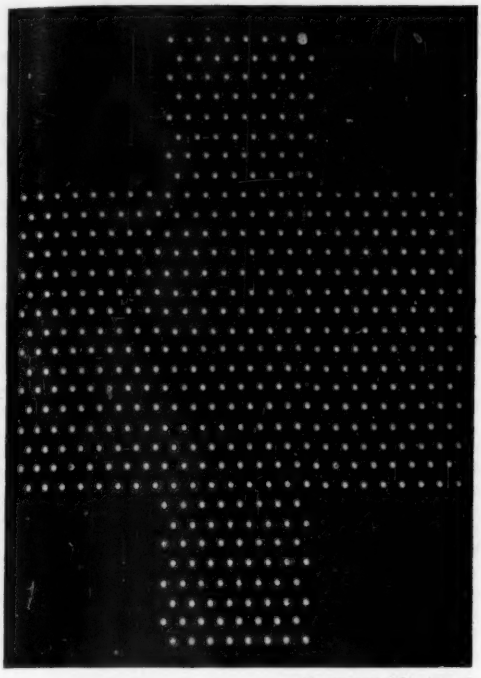
In a parallel machine of the same total capacity of n^2 digits in n cathode-ray tubes, a single number will be stored at n corresponding points on the n tubes. Again, if this number is required continuously, then each of its points will be regenerated n^2 times compared with its neighbour. It will be seen how much more serious is the interaction problem than in a serial machine.

When applying cathode-ray tube storage to the parallel computer now being built at the Telecommunications Research Establishment, Malvern, the dot–dash system was found to have several undesirable features. Although these features are all related, they may be considered under three main headings: (1) the interaction between elements of the store was such that the number of digits per cathode-ray tube had to be reduced to a point where it became impracticable for the requirements of a computer; (2) spurious signals due to imperfections of the fluorescent screen made selection of cathode-ray tubes necessary; with a high rejection-rate this was a costly process, and even then final anode voltages had to be limited to the order of 1 kV. in order to minimize these spurious signals; (3) the system was found to be extremely sensitive to variations of the deflexion voltages; even microphony of the valves producing the deflexion voltages could change the stored information.

Using the existing cathode-ray tubes, interaction could be reduced in two main ways: (*a*) reducing the net beam current; (*b*) increasing the final anode voltage of the cathode-ray tube, thus obtaining a finer-focused spot, and using a different portion of the secondary emission characteristics of the fluorescent screen.

A reduction in the net beam-current by about 20 per cent was first obtained by using what may be called a 'double dot' system, where the charge was re-established by a second dot placed a critical distance from the first. The refilling action of this system is slightly more efficient than the dot–dash method. Regarding final anode voltage, experiments showed that an increase reduced the interaction at the expense of signal strength; for example, an increase from 1 to 1·5 kV. enabled the separation between digits to be reduced from 1·8 mm. to 0·8 mm. for the same degree of interaction. This represents a fourfold increase in digits per unit area.

For about two years attempts have been made to manufacture cathode-ray tubes with screens which are free from storage imperfection; but so far as is known at the moment, no consistent results have been obtained. The majority of the imperfections were small compared with the cathode-ray tube spot, the diameter of which was 0·5 mm. In an effort to overcome their effect, the cathode-ray tube beam was modulated at 5 Mc./sec. at right angles to the line of the double dot. For six cathode-ray tubes tested, it was found that an amplitude of only 0·5 mm. was sufficient to make them work with a final anode voltage of 1·5 kV. All these tubes previously had only been satisfactory at 1 kV. A single cathode-ray tube store was now constructed



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with 256 digits using the above techniques. This was used in conjunction with an experimental portion of the computer.

On further consideration, however, the defocus–focus system appeared to have many advantages over the modulation system. These are: (1) the refilling process by means of the focused central dot is much more efficient than that using a displaced dot, being effected by electrons emitted in all directions, instead of by those emitted only in a particular sector; as a result, the net beam current may be reduced with a consequent reduction of interaction; (2) since the defocused inspection spot and the focused refilling spot are concentric, the chances that the charge barrier due to an impurity of the screen would prevent the re-establishment of the charge are very slight; (3) the charge of the digit is detected by a defocused spot, and the system is therefore less sensitive to errors of the deflexion voltage than when using a focused beam; (4) there should be an improvement in signal strength due to the increased quantity of charge in the defocused spot.

Experiments have confirmed these advantages. The duration of re-filling pulses can be reduced to 0·8 μsec. compared with about 2 μsec. with the double-dot system, and the total time for reading or writing a digit can be reduced to 2 μsec.

Many cathode-ray tubes have been tested to determine the effects of impurities on the screen, and all have proved completely satisfactory. One in particular, which had at least six large impurities and had been rejected for use in a dot–dash store at 1 kV., was found to be perfectly satisfactory in a defocus–focus system at 2 kV. No variation in signal strengths could be detected larger than those normally obtained due to the variation of screen surface.

Trouble previously experienced due to the microphony of the deflexion valves completely disappeared; consequently, reliability has increased and the stability requirements of the deflexion voltages have decreased.

The increased signal strength due to the increased charge per digit of the defocus–focus system tends to compensate for the reduction of signal due to the increase of final anode voltage, and satisfactory signal/noise ratios are still obtained with 2 kV. final anode voltage. An experimental cathode-ray tube store of 512 digits using the defocus–focus system has been functioning for about six months. Each storage element may have had at least 256 regenerations adjacent to it before being itself regenerated. This is the maximum requirement, provided instructions and numbers are used alternately and are stored in different areas of the cathode-ray tube. The digits are arranged with 2·5-mm. separation in a pattern as in the accompanying illustration.

The electrical and mechanical design of the store has been completed, and a prototype to this design tested. The twenty stores required for the computer are now in process of construction.

Experiments have also been carried out to determine whether this system is suitable for serial storage. It has been found that a square pattern of 1,024 digits can be stored, and that any digit may have its neighbours brightened-up at least 64 times before being itself regenerated.

The cathode-ray tubes used in the above work were of type *VCRX* 266. This is a convenient type of 6-in. tube with low beam current and small spot diameter. All those tested were found suitable for defocus–focus storage without the need of selection.

I wish to thank members of the Research Laboratory of the General Electric Co., Ltd., for their co-operation in the development of experimental cathode-ray tubes, and the Chief Scientist of the Ministry of Supply for permission to publish this communication. [April 18.

[1] Williams, F. C., and Kilburn, T., *Nature*, **162**, 487 (1948).
[2] Williams, F. C., *Proc. Roy. Soc.*, A, **195**, 265 (1948).
[3] Williams, F. C., and Kilburn, T., *Proc. Inst. Elec. Eng.*, **96**, Part III, No. 40, 81 (1949).
[4] Kilburn, T., *Nature*, **164**, 684 (1949).

ABILITY OF BIRDS TO COUNT

THE masters of 'clever' horses and dogs are often sincere in their belief that their pets really display intelligence of the highest order; for they are quite unable to imagine that the animals can really perceive small involuntary signs and signals which tell them when the right answer has been reached and hence when they must stop barking or stamping, as the case may be. Yet it is now quite certain that that is precisely what these 'clever' animals are doing. It was not the stallion "Zarif" of Elberfeld which reproduced Descartes's "*cogito ergo sum*" in ill-spelt German, nor was it the dachshund "Kuno" which answered the professor's question as to what creed he had with the words "Mine is yours". These 'clever' animals only obey their master's signs which, given at the proper moment, stop the barking or stamping by which they spell out their answers in code.

In a recent article (*Bull. Animal Behaviour*, No. 9; March 1951) Prof. O. Koehler states that the achievements of certain birds with which he has experi-

mented are examples of true learning and in no way dependent on clues, voluntary or involuntary, given by the experimenters.

During training and 'spontaneous' experiments the observer and the bird were always separated by a partition so that the experimenter was never seen by the bird; while at work he was able to watch it through the view-finder of a cine-camera fitted into the wall. Moreover, when a deterrent was required in conditioning, only one degree of punishment was used and this was always the same. It was thus impossible for the experimenter inadvertently to give signs by means of the punishing apparatus since the latter functioned along all-or-none lines.

Unlike circus animals, Prof. Koehler's birds were sometimes left entirely to themselves and the results recorded automatically so that all possibility of clues from the investigator was ruled out. The birds learned many tasks without any punishment and merely by self-conditioning. Often spontaneous experiments were made by the birds in the complete absence of any human being. The birds were often left alone with their task while the experimenter was kept far away so that even possible telepathic connexion between man and animal could be excluded. Nearly all the problems solved by the birds in spontaneous experiments were recorded automatically by film for later study.

Not even the cleverest of the birds showed inborn capacities like human beings; but they did learn unnamed numbers which were presented to them by two principal methods: (1) simultaneous presentation, and (2) successive presentation. The first of these abilities is that of being able to compare groups of units presented simultaneously side by side by seeing numbers of those units only, excluding all other clues. This problem was presented to birds in quite different ways, starting with only two groups of edible units (grains of corn, fruit, pieces of meat, etc.), the two groups differing by one unit only, and at the other extreme rising to choice according to pattern. A raven and a grey parrot were presented with five small boxes covered with lids bearing two, three, four, five and six spots each respectively—the key being a lid with one of these numbers of spots lying on the ground in front of the boxes. Both birds learned to open only that one of the five lids which had the same number of spots as the key pattern. As a control, everything was changed in a random manner from one experiment to the next. There were fifteen positions of the five boxes and very many different positions of the key pattern; the number of units in the key pattern changed with each experiment and there were five places for the "positive" number of spots on a lid corresponding to that of the key. Moreover there were twenty-four permutations of the four negative numbers. The relative situation of the spots of one group and, with the raven only, the size and form of those spots were also changed with absolute irregularity. In the final series of experiments, for each trial a flat 'Plasticine' cake was broken into pieces of highly irregular and broken outlines, the size of a piece varying from 1 to 50 units of surface area; care was taken to make the general patterns of the positive number on the lid as unlike as possible to that of the key pattern. In an experiment such as this it is believed that any clue foreign to the problem was excluded, and yet the raven solved the problem by choosing the positive lid according to the only item which was not changing through all the experiments, that is, the number of spots equal to that of the particular key pattern presented.

The second problem was to estimate, that is, to remember numbers of incidents following each other and thus to keep in mind numbers presented successively in time, independent of rhythm or any other clue which might be helpful. Here again many different methods were employed. At first birds were trained to eat only "x" grains out of many offered without any help being given from a figure. Another task was to eat only "x" peas which were rolled into a cup, one after another, at intervals ranging from 1–60 seconds. Here again there were no figures at all; the peas were delivered as if by a slot machine, one by one, the bird never seeing more than one pea in the cup. The same applied to opening lids of boxes standing in a long row until "x" baits had been secured; since the baits were arranged in the boxes in twenty or more distributions from one experiment to the next, the number of lids to be opened was constantly changing. Still more remarkable was the fact that birds learned to master up to four problems of this kind at the same time. For example, a jackdaw learned to open black lids until it had secured two baits, green lids up to three, red lids up to four, and white lids until it had secured five baits. Similarly, budgerigars learned to "act upon two" when the experimenter said "dyo dyo dyo" and upon three (take only three grains from the heap) when he uttered the words "treis treis treis . . .". A similar result could be obtained with a bell indicating two and a buzzer indicating three.

Since it would appear that, in this experiment, all external clues were carefully excluded, only an inner token could have been responsible for the birds ceasing action when the number was reached. The bird would appear to have made some inward marking of the units he was acting upon, and sometimes those supposed "inward marks" showed themselves in external behaviour in the form of intention movements.

The simplest explanation offered by Prof. Koehler for this inner marking is that it may be made up of equal marks, as if human beings were to give one nod of the head for one, two for two, and so on; it is suggested that this be called "thinking unnamed numbers". On the contrary, the most prodigal assumption which could be made is that the bird did the marking by unequal or qualitatively different marks in fixed order, as if human beings think 1, 2, 3, 4, 5, or, alternatively, a phrase of five different syllables. That, of course, would be named numbers, or real counting.

Apart from one case, Prof. Koehler's simplest assumption would appear to fit the facts best, there being no sign of "number intelligence" at all and no obviously progressive learning ability as in the case of children. Pigeons and budgerigars were considerably upset by changes in experimental conditions during training for a problem, whereas jackdaws grasped the transposition at once. One bird, after having learnt to open a lid with three spots and not touch a lid with four spots, was presented with three and four mealworms moving on the lids instead of spots. The bird hesitated a long time, but finally went to the three mealworms and left the four alone; instead of opening the lid it ate the mealworms from it without opening it at all.

It would thus appear that a given species of bird shows the same ability of grasping unnamed numbers whether they are presented simultaneously or suc-

cessively; but the ability differs with the species. Thus, with pigeons it may be five or six according to experimental conditions, with jackdaws it may be six and with ravens and parrots, seven.

Similar tests of the same ability have been carried out with man. In this case the groups of figures were presented tachistoscopically by lantern slides, shown simultaneously and carefully timed so that, while they may be fully seen, the time is too short for counting to take place. It is remarkable that, when this is done with human beings, the limit of achievement is of the same order as that shown by birds. Thus, few persons reach eight and many, like pigeons, get no farther than five. Experiments are still being carried out to test the second ability; but there is no expectation that man may achieve better results than the birds, provided named counting is excluded.

LONG ASHTON RESEARCH STATION FIELD DAY

THE exhibits at the Long Ashton Research Station Field Day on July 10 included several of particular scientific interest. In the Pomology Section, Dr. L. C. Luckwill demonstrated methods used in the biological assay of growth substances and inhibitors, and showed the application of paper chromatography to the separation and identification of growth substances. The test objects used were sections of wheat coleoptiles, unpollinated tomato ovaries, and excised nodes of *Coleus*. The application of these techniques to the study of problems of fruit set and fruit drop in apples was also illustrated. Another exhibit dealt with the use of α naphthalene acetic acid as a fruit-thinning agent. This substance applied to apple trees within three weeks of petal-fall has been shown to inhibit seed development, thereby leading to an increased drop of developing fruitlets. The method is likely to prove of value for improving fruit size in heavy-cropping varieties and in controlling biennial bearing.

Dr. D. J. D. Nicholas, of the Plant Nutrition Section, had exhibits elucidating the technique of employing *Aspergillus niger* (Mulder's strain) for the determination of metal micronutrients in soils and plant-tissue homogenates. The assay is specific and quantitative for each micronutrient and gives results which are often below the limits of chemical detection. The trace metal requirements of other species of *Aspergillus* and *Penicillium glaucum* were shown to be similar to those of *A. niger*.

Other aspects of the biochemistry of *A. niger* illustrated were sugar utilization, vitamin B_2 and B_{12} production, respiration-rates, amino-acid metabolism and dehydrogenase activity of spores, under various metal deficiencies.

Dr. Nicholas also demonstrated the incidence of iron deficiency in pot-soil culture plants of tomato given nickel, cobalt and zinc, singly and in combination, and in oat given copper only. The metals, including iron, are extracted from fresh leaf tissue with glass-distilled water in micro-mills made of 'Pyrex' glass. Cation exchange resins, for example, 'Zeokarb 215' or 'Amberlites I.R. 100' and '125', are used for concentrating the trace metals and for separating them from the anions. The metal contents of tissue homogenates before and after passage through ion exchange resins are determined as well as the total amounts in dry matter. The appearance of iron chlorosis is paralleled by a decrease in chlorophylls *A* and *B* as determined by a quartz spectrophotometer.

Another exhibit showed the degree of correlation between final yield of crop plants, grown in factorial experiments, and the mineral status determined for various plant portions, at intervals during the season. In this work, a fractionation of the total mineral nutrients is made by maceration techniques and deep-freeze methods. Correlation coefficients between the results of these methods and those of ash analysis were shown.

In the sand culture investigations under the direction of Dr. E. J. Hewitt, the main work demonstrated comprised a factorial study on cauliflower of the relationships of molybdenum supply to source of nitrogen. In this trial it was shown that leaf symptoms of molybdenum deficiency developed strongly with nitrate or ammonium nitrate but were less marked with nitrite or urea. Ammonium sulphate was toxic alone but not in the presence of added molybdenum-free calcium carbonate. Except for a slight ammonium toxicity, growth was good for all sources of nitrogen in the presence of a normal molybdenum supply.

Molybdenum toxicity (500 p.p.m.) was severe with urea or ammonium sulphate or citrate, but was barely evident with nitrite, nitrate or ammonium nitrate.

Ascorbic acid content of the plants was much reduced by molybdenum deficiency, independent of the type of nitrogen supply. These results suggest a role of molybdenum closely related to nitrogen metabolism but not entirely dependent on the source of nitrogen.

A feature of the work at Long Ashton is the extent of collaboration between the various sections. The Insecticides and Fungicides Section, for example, carries out conjoint work with the Sections of Organic Chemistry, Physical Chemistry, Entomology, Mycology and Pomology. Modifications of the structure of DDT were demonstrated in work by Dr. D. Woodcock, Mr. E. J. Skerrett and Miss P. M. James on the relationship between chemical constitution and insecticidal action. Dr. J. T. Martin's exhibit dealt with the extent and permanence of deposits of DDT and rotenone on apple shoots and on soft fruit. He showed also the progress of investigations on the active principles and methods of assay of derris root.

Dr. W. D. E. Thomas and Mr. S. H. Bennett illustrated the application of a radioactive tracer in following the absorption by apple, chrysanthemum, *Coleus* and bean plants of a systemic insecticide (*bis*dimethylaminophosphonous anhydride). The use of the radioanhydride has yielded information on the factors affecting the absorption of the insecticide by leaves, its translocation and its subsequent breakdown. Parallel biological experiments on aphids using the radio-inactive anhydride permit an evaluation of the lethal concentration within the leaves.

Other applications of the use of radioactive tracers were shown in pot culture studies on the phosphate uptake of tomatoes in cobalt-rich soil (Drs. Thomas and Nicholas) and on the effects of clean cultivation compared with grass cover on the phosphate uptake of apple root stocks (Drs. Thomas and C. Bould).

Miss A. Crang and Miss M. Sturdy, of the Domestic Preservation Section, had on view bottled fruit

showing the effect of temperature of processing on the enzyme activity of pears and plums. Some varieties of both fruits have an oxidase enzyme system which is still active at temperatures which had been recommended for bottling as sufficient to prevent spoilage by micro-organisms. The result is that the uppermost fruits, in the headspace of the jar, become brown and this discoloration spreads over the rest of the fruit if left partly uncovered for any length of time after opening.

An investigation of the enzyme activity in these fruits shows that it varies considerably in the different varieties and stage of ripeness of the fruit. Higher temperatures or longer times of processing are being worked out to prevent serious discoloration without over-cooking. R. W. Marsh

MIXING AND AGITATING

ALTHOUGH agitation constitutes one of the basic or unit operations of chemical engineering and finds application, in one form or another, in nearly every major industry, very little is yet known about its mechanism or about the efficiencies to be expected from well-designed industrial stirring equipment.

A conference on "Mixing and Agitating in Liquid Media", arranged by the Institution of Chemical Engineers and held at the Royal Institution on July 17, was opened by Sir Harold Hartley, president of the Institution of Chemical Engineers. Sir Harold emphasized the need for more research and practical data on the hydrodynamics of systems in turbulent motion; and he referred in particular to the factors governing the operation and efficiency of processes such as that of the catalytic hydrogenation of fats, in which the three-phase interface required for rapid reaction has to be produced by agitation.

The introductory paper to the conference was given by Prof. D. M. Newitt, G. C. Shipp and C. R. Black, and reviewed briefly recent theoretical developments relating to the conditions which must be imposed upon heterogeneous systems to give rise to, and maintain, dynamic uniformity. The extent to which existing equipment reproduces the 'ideal' flow pattern for rapid and complete mixing was discussed by B. N. Reavell, who showed how a knowledge of the flow properties and viscosities of suspensions can be made to serve as a basis for classifying the wide variety of mixing problems encountered by the chemical engineer.

The importance of the application of hydraulics and hydrodynamics to the study of mixing was referred to by several speakers. Describing the mixing action of free jets, H. Fossett advocated the use of models to enable the hydraulic criteria governing their action to be established. From a rather different point of view, Prof. F. H. Garner and A. H. P. Skelland illustrated, by a ciné-film, the conditions under which internal circulation can be produced in droplets of a dispersed liquid phase; their experiments lead to the conclusion that the surface viscosity of the fluid in the droplet is probably a major factor in determining the onset of circulation.

The more practical aspects of the subject were dealt with in two papers devoted to the special problems of the fuel and ceramic industries. R. A. A. Taylor, of the Fuel Research Station, described the processes by which coal is suspended in, or incorporated with, water, oil, tar and other liquids, while F. J. Goodson and Dr. A. E. Dodd discussed the manufacture of earthenware bodies by a method in which the ingredients—china clay, ball clay, calcined flint and Cornish stone, disintegrated and dispersed in water—have to be mixed in the correct proportions and as uniformly as possible In both papers the operational and economic factors governing the choice of equipment were stressed.

Among the visitors taking part in the discussion were Mr. Thomas Chilton, president of the American Institute of Chemical Engineers, and Prof. H. A. Kramers, of the University of Delft.

D. M. Newitt

ORIGIN AND IMPROVEMENT OF CULTIVATED PLANTS

A USEFUL review by M. B. Crane of past and present methods used in crop improvement forms the text of the Masters Memorial Lectures of the Royal Horticultural Society for 1950 (*J. Roy. Hort. Soc.*, **75**, Parts 11 and 12; November and December 1950). Most of the crops of gardens and farms in Great Britain have attained their present economic desirability either as gene-mutations, through autopolyploidy, or by selection of interspecific hybrids with or without chromosome doubling. The sweet pea, Chinese primula, tomato, raspberry and edible pea are examples of improvement by gene-mutations.

Periclinal chimæras combined with gene-mutations have given certain economically acceptable plants. The potato variety Golden Wonder is a periclinal gene-mutation of the older Langworthy, differing only in its skin. Raspberries, pears, apples, tulips, hyacinths and narcissi are examples of plant improvement by autopolyploidy; chromosome numbers of the 'wild' form have been trebled or quadrupled in the cultivated variant. The strawberry provides an example of interspecific hybridization between the species *Fragaria vesca*, *F. elatior*, *F. virginiana* and *F. chilænsis*. Plums have arisen as interspecific hybrids between *Prunis cerasifera* and *P. spinosa*; but here the hybrid has been subject to polyploidy.

Mr. Crane dealt in his second lecture with the use and extension of these methods in practice. Polyploidy can be induced by treatment with the drug colchicine, by heat shock of plant shoots at 45° C. for one or two hours, by decapitation, and by exposure to X-rays. The action and interaction of genes is now studied very intensively, though the effect is to reveal a complexity far more bewildering than the original Mendelian ratio. This knowledge is put to practical use, however, in such problems as that of raising the vitamin A content of maize. The gene affecting this is related with endosperm colour. Octaploid organization of the dahlia makes possible the fascinating variations of the flower; the expression of dominance is more variable than in diploid plants. Vegetative propagation is a method of perpetuating hybrid vigour, and this fact could be used more consciously by plant improvers. Several examples were given of breeding for resistance to fungal diseases and insect pests. This problem is, however, complicated by the occurrence of strains in the disease-producing fungi, but several examples of valuable degrees of resistance are now known. They contribute significantly to the economy and food of nations.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Measurements of Mass Ratios in Nuclear Emulsions

In an earlier communication in *Nature*[1], we have described a method of measuring photoelectrically the density of tracks in nuclear emulsions. It is analogous to the method of grain counts and can be used with electron-sensitive emulsions where the overlapping of individual grains prevents the use of the latter method. We have compared the residual ranges of particles from regions of their tracks which show the same projected area per unit length, that is, the same average track width. From these comparisons we have calculated the mass ratios. This corresponds to the method used by Lattes, Occhialini and Powell[2] in grain counting.

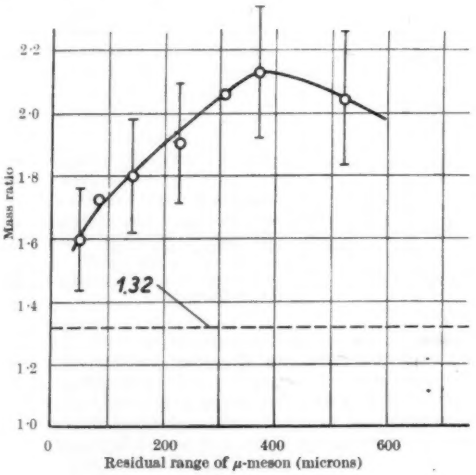

Fig. 1

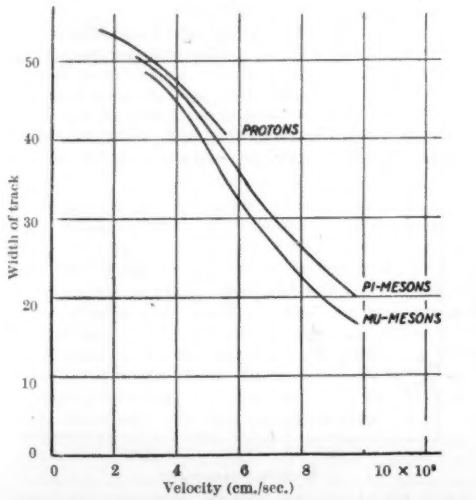

Fig. 2

Fig. 1 shows the ratio between the π- and μ-meson masses obtained in this manner. Fig. 2 shows the velocities corresponding to equal track widths, taking for the masses of protons, π-mesons and μ-mesons the values 1,840, 276 and 212 electron-masses respectively on the assumptions which have been made by Lattes, Occhialini and Powell. Our diagrams show a mass ratio which differs from the value 1·32 given by measurements in Berkeley and varies along the tracks. In this connexion it may be of interest to remember that Lattes *et al.* found the value 1·65 from measurements in nuclear emulsions. The explanation of the anomaly which we have found must be looked for either in an effect connected with the photographic process, or in some effect of the interaction of the particles with matter to which no attention has so far been paid.

A detailed account of the experiments will be given elsewhere (see also the letter by Prof. T. Gustafson which follows).

Sten von Friesen
Krister Kristiansson

Physics Department,
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June 15.

[1] *Nature*, **166**, 686 (1950).
[2] *Nature*, **160**, 453 (1947).

Density of Tracks of Protons and Mesons in Photographic Emulsions

The experiments by von Friesen and Kristiansson described in the preceding communication indicate that, at the same velocity, π-mesons give a smaller track width than protons, and μ-mesons smaller than π-mesons. The pertinent velocities, $c/5$–$c/3$, lie below those of the Čerenkov effect.

In investigations with photographic emulsions, the assumption is made that the track density, or the probability of making a certain fraction of the grains traversed developable, depends only on the ionization. According to the well-known work of Bohr, Bethe, Bloch, etc., the ionization of electrons by a particle with velocity v, charge e and mass M depends essentially on v and e. The mass M occurs only as a small, and in this connexion unimportant, correction.

We will first discuss the possibility of an explanation connected with the photographic process. According to current photographic theories, the developability of the silver bromide crystals depends on the ionization of the electrons and on certain small lattice defects in the silver bromide. Interstitial silver ions and vacant silver ion lattice sites are supposed to play the most important part in chemically non-sensitized emulsions. The number of such silver ions in a grain is, in our case, supposed to be of the order of 1,000.

It is important that very few silver atoms, perhaps of the order of 10, may be supposed to form the latent image making the grain developable. To form an interstitial silver ion, an energy transfer of about 1 eV. is needed. We have calculated the probability that one of the silver ions in a grain of diameter 0·6 μ gains at least 1 eV. by Coulomb interaction. For a velocity of $c/3$, this probability is only 0·07. For $c/5$ the corresponding figure is 0·19. Even considering the very great sensitiveness of the photographic process, these figures seem to be small. Further, they are in the first approximation inde-

pendent of mass, so that the difference for protons and mesons is very small. Also other effects, such as the temperature rise in the vicinity of the track, seem to be small and essentially independent of mass. Interactions of the particle with protons in the gelatine are mass-dependent but very small, and it seems difficult to connect them with effects on the grains.

Thus it seems reasonable also to discuss the possibility of specific properties of the mesons, namely, specific interactions between μ-mesons and electrons, and between π-mesons and electrons, which then must be different. In the ionization by electromagnetic forces, distant and near collisions contribute about equally. The assumption of additional short-range interaction has to provide for a reduction of the effect of the near collisions of about 15–20 and 30–40 per cent respectively to be able to account for the experiments. If both positive and negative mesons occur in the experiments, the interaction has to change sign with meson charge. An interaction can exist only for charged mesons.

Further experimental and theoretical work is in progress.

Torsten Gustafson

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June 15.

Mechanical Properties of α-Solid Solutions of Copper, with Zinc, Gallium, Germanium and Arsenic

The strengthening of metals by alloying elements in solid solution is often attributed to the local distortions of the lattice due to the difference in size between the solute atoms and the solvent atoms. In 1942 [1], Hume-Rothery and Frye showed that in a series of silver alloys the ultimate Meyer hardness brought about by a given percentage of solute atoms was proportional to the square of the lattice distortion for solutes in the same row of the Periodic Table. In 1950, Dorn, Pietrokowsky and Tietz [2] published the results of tensile tests on a series of aluminium alloys, and showed that the increase in strength was not attributable solely to the lattice strain; but that effects due to the difference in valency between solvent and solute must be taken into account. Thus, they suggest that the hardness of the alloys is given by the equation

$$F = \Delta a + K\Delta v,$$

where F is hardness; Δa is change in lattice constant; Δv is $\frac{\text{atomic per cent solute}}{100} \times$ (valency of solute − valency of solvent); K is constant (approximately 1). In their work the unexpected valency of 2 was assigned to aluminium.

We have examined the tensile properties of copper–zinc, copper–gallium, copper–germanium and copper–arsenic solid solutions. When these alloys are produced by identical methods in the form of soft annealed wires of approximately equal grain-size, the ultimate tensile strength and resistance to plastic deformation appear to be almost entirely governed by the electron–atom ratio of the alloys. Fig. 1 shows, for example, the true stress/strain curves of a copper–zinc alloy with 9·00 per cent by weight of zinc, a copper–gallium alloy with 4·65 per cent of gallium, a copper–germanium alloy with 3·34 per cent of germanium, and a copper–arsenic alloy with 2·48 per cent of arsenic. All these alloys have electron–atom ratios (assuming the usual valencies of the metals) of about 1·087, and their stress/strain curves are as nearly alike as those of four samples of the same wire would be. Fig. 2 shows the 0·5 per cent proof stresses of all the alloys, plotted as a function of electron concentration.

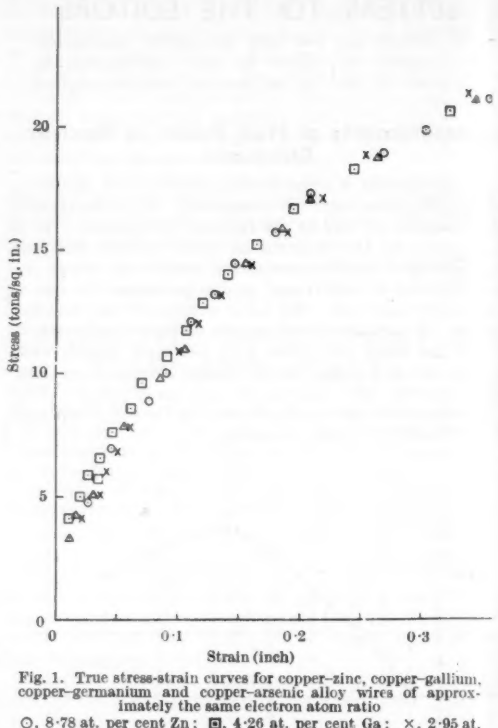

Fig. 1. True stress-strain curves for copper–zinc, copper–gallium, copper–germanium and copper–arsenic alloy wires of approximately the same electron atom ratio

○, 8·78 at. per cent Zn; ⊡, 4·26 at. per cent Ga; ×, 2·95 at. per cent Ge; △, 2·12 at. per cent As. Electron concentration = 1·087 approximately

In this case the alloys behave as if the solute atoms were completely ionized. The increase in the concentration of free electrons in the alloys in Fig. 2 is not more than 18 per cent, and may not account directly for the increased proof stress of the alloys. It seems probable that the high positive charges associated with the solute ions are in some way the

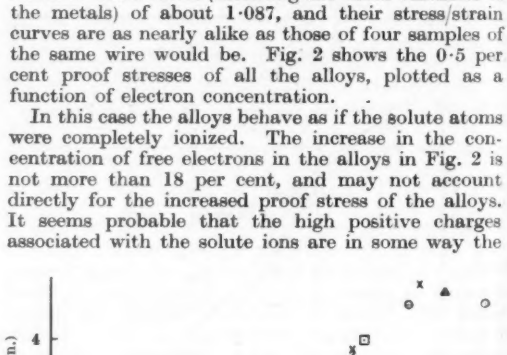

Fig. 2. 0·5 per cent proof stress. ○, copper–zinc; ⊡, copper–gallium; ×, copper–germanium; △, copper–arsenic

cause of the increased resistance to plastic deformation of the solid solutions.

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T. H. Schofield
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April 14.

[1] *Proc. Roy. Soc.*, **A**, **181**, 1 (1942).
[2] *J. Metals*, **188**, 933 (1950).

Changes in Lattice Constants of Cr_2O_3 near the Curie Temperature

It has been pointed out[1] that there is a correlation between magnetic and structure transition temperatures for certain antiferromagnetic materials. In the case of Cr_2O_3, with a Curie temperature of approximately 314° K., it was reported that the $42\bar{2}$ reflexion was resolved into a doublet below the Curie temperature. This communication presents additional information concerning the nature of the structure change responsible for the doublet formation mentioned above.

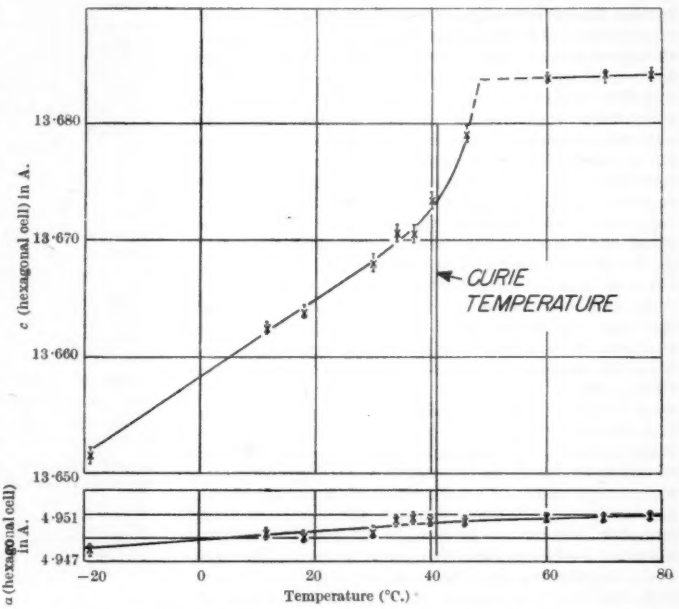
A 10-cm. diameter symmetrical back-reflexion camera was used to provide the high resolution required. An arrangement was made for varying the temperature of the sample from 250° to 360° K. to within ± 1° K. The powdered specimen was mounted on a copper block which had been machined to the proper radius of curvature. For low-temperature measurements, various liquids were circulated through holes in the copper block, which was secured to a 'Bakelite' section to ensure thermal insulation of the photographic film. For high-temperature measurements a heating element was attached to the block. Filtered molybdenum, chromium and copper radiation were used. In the case of copper radiation, a nickel foil (0·001 in.) was placed directly over the photographic film to reduce fogging due to secondary scattering.

Back-reflexion photographs with chromium or molybdenum radiation showed no pattern changes throughout the temperature-range investigated. In the case of copper radiation, the $42\bar{2}$ and 652 reflexions, which coincide above the Curie temperature, separate into two clearly resolved reflexions as the temperature is lowered. This is the result which was reported as the splitting of the $42\bar{2}$ reflexion. Calculations for the $\sin^2\theta$ range covered by the camera for molybdenum or chromium radiation show that there should be no superposition of reflexions if a rhombohedral angle of 54° 45′ is assumed for Cr_2O_3. For copper radiation, however, the $42\bar{2}$ and 652 reflexions coincide. If the rhombohedral angle is appreciably changed, then the condition for superposition of the two reflexions no longer holds. The observations show that above 320° K. the rhombohedral angle is essentially constant and that in a 13°-range below this there is a sharp increase of 2′. An additional increase of 2·5′ occurs as the temperature is reduced to 255° K.

As Cr_2O_3 goes through the transition temperature, the unit cell contracts markedly in the [111] direction, whereas in the direction perpendicular to this the contraction is almost normal.

For ease of calculation the transformation to a hexagonal cell was made. The c- and a-dimensions of the hexagonal unit cell are shown in the accompanying graph as a function of temperature.

The chromium atoms in Cr_2O_3 each has one nearest neighbour at a distance of approximately 2·8 A. Néel[2] has suggested a magnetic structure for Cr_2O_3 in which the atoms in the closely spaced pairs (which lie along the [111] direction) tend to have antiparallel spin alignments. The spin directions of a given pair are also correlated with the spin directions of neighbouring pairs. In such a structure there are ferromagnetic sheets of atoms in the (111) planes with spin directions alternating from plane to plane. An explanation for the correlation between the magnetic structure and the anomalous contraction along the [111] direction has been suggested in a previous paper[3].



The c- and a-dimensions of the transformed hexagonal unit cell of Cr_2O_3 as a function of temperature

There is no indication of a discontinuity in the unit-cell volume as a function of temperature. This is in agreement with the concept that the Curie temperature transition is a second-order phase transition.

This work was supported in part by the U.S. Office of Naval Research.

Selma Greenwald
U.S. Naval Ordnance Laboratory,
White Oak, Silver Spring 19,
Maryland. March 20.

[1] Greenwald, S., and Smart, J. S., *Nature*, **166**, 523 (1950).
[2] Néel, L., *Ann. de Phys.*, **3**, 137 (1948).
[3] Smart, J. S., and Greenwald, S., [*Phys. Rev.*, **82**, 113 (1951).]

Cube-Edges of Uraninites as a Criterion of Age?

I HAVE suggested that there is a progressive reduction in the size of the unit cell of uraninite-thorianites with time[1]. The ionic radius of Pb^{4+} is appreciably smaller than those of U^{4+} and Th^{4+}. The decay of the parent element causes its substitution by radiogenic lead within the crystal lattice; because of the differences in sizes of the ions, a shrinkage results. It is therefore likely that this factor can be utilized for indicating the relative ages of uraninites after these have been subjected to an X-ray powder examination. No great accuracy can be envisaged, but such a method would be more accessible to geologists than the highly refined mass-spectrographic one, which can be practised in very few laboratories in the world.

There is a dearth of reliable X-ray data. The recently published values by Arnott[2] are not acceptable, as the systematic errors, inherent particularly in the X-ray determinations of uraninites, were not considered. His results are not correct to the number of significant figures given. I have used the well-known graphical extrapolation method evolved by Bradley and Jay[3], as previously advocated[4]. The only value found in the literature that can be considered accurate is the one recorded by Ingerson[5] for a uraninite from Connecticut. The limits of error are given as $\pm$ 0·006 A. in Ingerson's paper; this is about double the error with which the new determinations were made in this report. Temperature, although observed, has not been considered further, as its effect is thought to be well below the limits of error in this investigation.

In order to assess the reductions of the unit cell, and also to arrive at a correction for the thoria content in uraninites, the cube-edges of specially purified uranium oxide (UO_2) and thorium oxide (ThO_2) were determined, giving respectively 5·470 and 5·599 $\pm$ 0·002 A. Assuming Vegard's law for the series UO_2—ThO_2, an approximate correction was applied according to the ratio of uranium oxide to thorium oxide in the uraninites. In order to do this, only material which had been analysed was examined by X-rays, except the Belgian Congo samples, which are known to be nearly free from thoria; here two samples were tested. The work rests largely on specimens described by Mountain and Holmes[6-8]. The main objective is to measure the effect of the substitution by lead, and the selection of samples is such that other substitutions are of very minor importance.

All the cube-edge values (a_0) in the accompanying table are new observations except the Connecticut one (*op. cit.*). The results show that when allowance for the expansion due to thorium is made, uraninites have a lower cube-edge than pure, lead-free uranium oxide; this is taken as proof that the lead substitutions take place as postulated above. The first five results (above the line) support the thesis that a progressive reduction in the unit cell does take place with the passing of time. This shrinkage ranges from 0·0025 A. to 0·0041 A. per hundred million years, and such segments of time can be recognized by this method—even with the present limits to accuracy. The narrow variation in the 'shrinkage rate' of four widely differing samples is significant.

Sample	Age (million years)	a_0: determined	a_0: corrected for thoria
UO_2, artificial	0	5·470 A.	5·470 A.
Connecticut (*ex* Ingerson)	280	5·465 A.	5·463 A.
Belgian Congo	600	5·453 A.	5·453 A.
Bisundni (*ex* Holmes)	730	5·448 A.	5·446 A.
Namaqualand (*ex* Mountain)	1,000	5·444 A.	5·429 A.
Gaya (*ex* Holmes)	950	5·481 A.	5·464 A.
Wilberforce (*ex* Holmes)	1,000	5·482 A.	5·460 A.
Namaqualand (*ex* Holmes)	1,000	5·485 A.	5·460 A.

(Increase ↓ in age; decrease ↓ in determined a_0)

The last three results appear to negative the other results—as a group: among themselves they show the agreement one might expect from the premises set out. The high thoria content common to these samples cannot alone be responsible for their anomalous (?) position, for both groups have a similar, if not identical, Namaqualand sample. The frequently observed loss of thorium D, that is, lead, in thorium-rich minerals may contribute here to give the anomalous (?) high results determined.

The results are considered encouraging, and suggest a method of limited application; but further study is indicated and is proceeding. A more detailed account is also being prepared for another journal.

It is difficult to refrain from trying to apply the little that seems established so far to local geological problems, for example, the age and origin of the Rand gold deposits. Uraninite concentrates from three different gold mines of the Witwatersrand have yielded cube-edge values ranging from 5·440 to 5·454 A.; reduction due to a minor thorium content brings these values within the range 5·436–5·449, with an average near 5·442 A. These uraninites are totally different from those from Namaqualand but somewhat comparable to the Bisundni material. The more pronounced shrinkage of the Rand uraninites indicates, however, a greater age which would be about 850 million years. This age would be in harmony with the 'placer origin' of the uraninite, along with the gold, in the pre-Cambrian sediments of the Witwatersrand system.

B. WASSERSTEIN

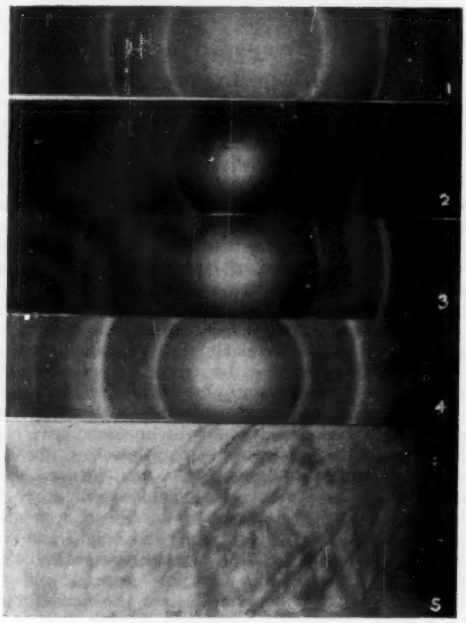
Geological Survey,
P.O. Box 401,
Pretoria.
April 16.

[1] Wasserstein, B., *Proc. Geol. Soc. S. Afr.* (in the press).
[2] Arnott, R. J., *Amer. Mineral.*, **35**, 386 (1950).
[3] Bradley, A. J., and Jay, A. H., *Proc. Phys. Soc.*, **44**, 563 (1932).
[4] Wasserstein, B., *Amer. Mineral.*, **36**, 102 (1951).
[5] Ingerson, E., *Amer. Mineral.*, **23**, 269 (1938).
[6] Holmes, A., *Trans. Edin. Geol. Soc.*, **14**, 176 (1948).
[7] Holmes, A., *Geol. Mag.*, **86**, 288 (1949).
[8] Holmes, A., *Amer. J. Sci.*, **248**, 81 (1950).

Electron Diffraction by Clay Minerals with a Fibrous or Rod-like Habit

CLAY particles deposited from a suspension on to a cellulose film are usually strongly orientated with their basal (001) planes parallel to the film. Electron diffraction patterns obtained with the beam normal to the film reveal only the (*hk*0) diffractions. For most types of clay the corresponding spacings are so alike that such diffraction patterns do not help in identification.

Recently, however, we have found that, of the layer-lattice type clays, halloysite is an exception in this respect. Electron microscopy reveals a rod-like habit of halloysite in contrast to the hexagonal plates of its close chemical analogue, kaolinite. Electron diffraction patterns of these two clays obtained in transmission with normal beam incidence are also significantly different and not only distinguish clearly between these two but also enable halloysite to be identified with certainty (Figs. 1 and 2). The innermost ring in the halloysite pattern corresponds to the characteristic (001) basal spacing of 7·4 A. This ring is not present in the pattern obtained from kaolinite. Its appearance in the halloysite pattern is due to the effect of the rod-like habit in determining the crystal orientation.



(1) Kaolinite. (2) Halloysite. (3) Attapulgite. (4) *Argilla esmectica verde.* (5) Electron micrograph of *argilla esmectica verde* (×10,000)

Another fibrous clay mineral, attapulgite, which, however, has not a layer-lattice structure, also gives a characteristic normal transmission pattern (Fig. 3) distinct from that of the other clay minerals. The innermost ring corresponds to the (110) spacing of 10·48 A.[1]. Dehydrated montmorillonite and illite have a basal spacing of this order; but this spacing does not appear in their patterns obtained by normal transmission. A Spanish clay, *argilla esmectica verde*, clearly shows this spacing, and its electron diffraction pattern (Fig. 4) as a whole resembles that of attapulgite. Its electron micrograph (Fig. 5) definitely indicates a fibrous habit.

The specimens of halloysite and the Spanish clay were obtained from Dr. D. M. C. MacEwan, of Rothamsted Experimental Station; that of kaolinite from Mr. R. Scott-Russell, of the Department of Agriculture, University of Oxford; and that of attapulgite from Attapulgus, Georgia, through the courtesy of Dr. S. P. Raichaudhuri, of the Indian Agricultural Research Institute, Delhi.

We should like to thank Prof. G. I. Finch for his interest; Mr. H. I. Matthews for the electron micrograph of the Spanish clay; and the Agricultural Research Council, which is supporting the work.

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An Interference Spectrometer for the Infra-Red

The Fabry–Perot interferometer can be used for examining absorption spectra provided that there is no overlapping between successive orders of interference. This means that the range between orders must be equal to, or greater than, the spectral slit-width of the primary monochromator[1]. Suppose that, using a given interferometer, it is possible to resolve a fraction Δm of a fringe order, then under the above condition the resolving power of the combination of interferometer and primary monochromator is more than $1/\Delta m$ times that of the latter alone.

It can be arranged that the diameters of the fringes are very large compared with the height of the monochromator entrance slit on which they are projected, so that the slit embraces only a small fraction of an order. By rotating the interferometer about an axis parallel to the length of the slit, the fringe pattern is passed over the slit, and its structure can be analysed by placing a detector behind the exit slit. In this manner, the Fabry–Perot interferometer may be employed to study *absorption* in spectral regions where photography is not possible. In particular, it can replace the diffraction grating for certain work in the infra-red, leading to a cheaper and more compact spectrometer.

We have constructed an instrument of this kind with glass optics and used it to study absorption spectra under moderately high resolution. For example, the prism monochromator alone just resolves the rotational structure of the harmonic band of HCl at 1·76 μ. When crossed with a Fabry–Perot interferometer having a range between orders of about 16 cm.$^{-1}$, the isotopic fine structure[2] of each rotational band is clearly revealed.

The relatively long wave-lengths of the infra-réd region make it possible to use for the interferometer optical flats which are less perfect than those normally required for the visible region. Furthermore, the order of interference is rather low and, as a consequence, the plate separation is small, so that the interferometer is very stable and robust. Antimony seems to be a suitable material for semi-reflecting films, having moderate reflexion and satisfactory transmission coefficients in the range[3] between the visible region and 25 μ. Other possible materials are being examined.

An attempt is being made to link together the motions of the prism and interferometer plates in such a way that the order of interference of the fringe falling on the slit is held constant as the prism is rotated. By this means, it will be possible to

record an extended region of the spectrum directly, instead of in steps each of which is equal to the spectral slit-width of the primary monochromator.

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Statistical Theory of Solutions

The report of a discussion on this subject[1] prompts me to publish a simple equation which I obtained some time ago for the water vapour pressure isotherm of sulphuric acid solutions. Sulphuric acid is the only liquid that gives heats of mixing with water which are comparable with the heat of wetting of wool, and because the solution is free from mechanical restraint, I set out to determine how far the solution deviated from the regular solution formula[2].

The first step was to determine ω in the equation :

$$\Delta H = \frac{N_A N_B}{N_A + N_B}\,\omega. \qquad (1)$$

This can be written :

$$\Delta H = \frac{i/x}{i + 18/x}\,\omega, \qquad (2)$$

where i is the number of grams of water per gm. of dry sulphuric acid, and x is the effective 'molecular weight' of sulphuric acid in the solution. Equation (2) is identical with that used by Katz[3] to express his observed heats of mixing. His empirical constants give x as 55—not far removed from one-half the true molecular weight of sulphuric acid—and ω as 16·5 kT.

The second step was to find the vapour pressure relationship from :

$$\frac{p}{p_0} = \frac{N_A}{N_A + N_B}\exp\left\{-16{\cdot}5\left(\frac{N_B}{N_A + N_B}\right)^2\right\} \qquad (3)$$

taking the molecular weight of sulphuric acid as 55 and that of water as 18.

On proceeding to evaluate p/p_0, I found that the term

$$\xi = \exp\left\{-16{\cdot}5\left(\frac{N_B}{N_A + N_B}\right)^2\right\} \qquad (4)$$

gave the water vapour pressure isotherm for all concentrations, possibly to within the limits of experimental error. The comparison with Wilson's[4] pressure data at 25° C. is given in the accompanying table.

H_2SO_4 (%)	5	10	20	30	40	50	60	70	80
ξ	0·99	0·98	0·91	0·77	0·58	0·37	0·17	0·047	0·005
p/p_0 (obs.)	0·99	0·96	0·89	0·76	0·57	0·37	0·17	0·052	0·008

A superficial interpretation of this coincidence is that two water molecules become attached to each sulphuric acid molecule, which is not unreasonable, and that there is no entropy of mixing. Such a conclusion, if true, should be of general application to solutions with large heats of mixing, but these seem to be few in number. The scanty data available for phosphoric acid show equally good agreement with ω as low as 4·5 kT, but glycerine with 0·73 kT does not obey this relationship.

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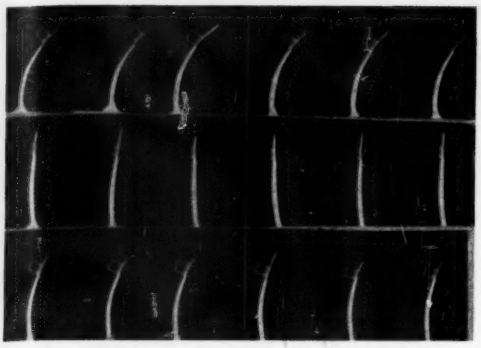
Growth Hormones of Rice Grains Germinated at Different Temperatures

Knowledge of hormone concentration in rice is very meagre. So far as we are aware, systematic attempts have not been made to assay and to ascertain the nature of hormones in rice grains. Avery, Berger and Shalucha[1], in their work on auxin yields from various plant materials, mentioned the auxin content of rice endosperm. Since the publication of their results, improved methods of extraction with greater yield of hormone from plant tissue have been suggested. Hatcher[2] has assayed the hormone content of several grains and studied the relation of its concentration with vernalization response ; but in his list rice grain was not included. The importance of hormone and its relation to vernalization and photoperiodic response has been emphasized by Gregory and Purvis[3], and Cholodny and Cailahjan[4].

It has been suggested previously[5] that the concentration and distribution of the hormone have been the cause of the variation of the flowering duration of tillers and main shoot of rice, var. *Rupsail*. The influence of low temperature is not obligatory for flowering, but its influence on increased vegetative growth as indicated by tillering and height has been noted[6]. The effect of low-temperature stimulation leading to increased vegetative growth and the photoperiodic response emphasizes the need for the knowledge of growth hormones in rice. It would be interesting to find out how far auxin production in rice is related to increased vegetative growth by low-temperature stimulation and to photoperiodic response. In this work the auxin content of rice grains germinated at two different temperatures are noted.

A chamber recently devised by us[7] for the assay of growth hormones in the tropics was used for determining the auxin content of grains of rice and other cereals, and different methods of hormone extraction were compared. An appreciable quantity of hormone has been detected in water extraction. It appears that water extraction alone is effective for the removal of auxin from the endosperm of rice. Higher auxin content by sodium hydroxide extraction is due to slow hydrolysis of auxin precursors as shown by Avery, Berger and Shalucha. In this variety of rice auxin yield is 0·17 million T.D.C. in water and 0·50 million in alkali extraction per gm. of dry endosperm. Avery, Berger and Shalucha noted hormone content to be 0·25 million of T.D.C./gm. in alkali extraction.

The increased auxin content in the present



Avena curvatures for the hormone extract from the endosperm of rice. Top, 0·50 million T.D.C./gm. from dormant endosperm; middle, 0·059 million T.D.C./gm. after 5 days germination at 26° C.; bottom, 0·228 million T.D.C./gm. after 5 days germination at 10° C.

investigation is possibly due to varietal difference and the modification of the extraction method employed.

The assay of the hormone content of rice grains germinated at different temperatures shows that a marked inhibition of the consumption of auxin from the endosperm tissue takes place at 10° C. together with the inhibition of the seedling growth, while at 26° C. a large amount of hormone, about 88 per cent of the total content, disappears from the endosperm within five days (see accompanying illustration). A comparison of the growth of the seedlings shows that during five days the seedlings cultured at 26° C. have two unfolded leaves with 6·2-cm. root and 4·2-cm. shoot length, whereas at 10° C. they have 0·2–0·3-cm. root and shoot length is only noticeable. High auxin content of the seeds germinated at 10° C. was due to the interruption of the hydrolytic reaction yielding auxin from its precursor. Temperature appears to have an effect on the hydrolysis of auxin precursor contained in the endosperm tissue, and the disappearance of hormone from the endosperm has been found to be due to the activity of the growing embryo, as the hormone content is very little changed after the excision of the embryo (see accompanying table).

Exp.	Average degree of *Avena* curvature	Millions of T.D.C./gm. in alkali extraction
Temperature of hydrolysis		
27° C.	27·3	0·50
22° C.	22	0·44
10° C.	16	0·32
5° C.	9	0·18
Endosperm after 48 hr.; 24 hr. with embryo and 24 hr. without embryo	23·6	0·225
Endosperm after 24 hr. with intact embryo	24·2	0·262
Endosperm after 48 hr. with intact embryo	18·7	0·155

In order to ascertain whether the gradual disappearance of hormones from the endosperm was due to the presence of growth inhibitors, the activity ratio of the endosperm extract was assayed by the Skoog's deseeded and Went's standard methods as suggested by Avery, Berger and Shalucha. The ratio found, 3 : 1, is suggestive of the absence of growth inhibitors in the rice endosperm.

We desire to express our sincere thanks to the University of Calcutta for facilities for carrying out this work in the Department of Botany, and to Dr. B. P. Pal, director, Indian Agricultural Research Institute, New Delhi, for his interest and the supply of pure seeds of oat.

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Chromosome Elimination in *Saccharum*

In the sugar-canes there are two cytological features of interest. First, it has been noticed that two types of egg gametes, one with the reduced haploid number of chromosomes and the other with the unreduced diploid number, are formed. From a study of chromosome numbers in certain hybrids (Table 1), it can be seen that in some crosses one or other of these types of gametes, or both, have functioned.

Recent investigations by Bremer[1] have shown that the restoration of the somatic number in the megaspores takes place by a process of endomitosis in the innermost megaspore cell after normal meiosis had taken place. Secondly, it is known that the unreduced gametes of the female parent are capable of developing without fertilization. This is particularly the case in wide crosses such as *POJ* 2725 × *Imperata*[2], and *Co.* 421 × *Coix lachryma-jobi* or *Bambusa arundinacea*[3].

In addition to the two features referred to above, another interesting point was also noticed. The anomalous chromosome numbers of certain seedlings among the hybrids (Table 2) indicated that egg gametes with chromosome numbers different from the haploid or the diploid number had functioned, since the male parents, the meiosis of which was known to be normal, could have contributed only the regular haploid number of chromosomes.

Co. 421, a male-sterile commercial cane, was used as a female parent in a number of crosses and was also selfed under bag. From these, both in wide crosses and in selfs, two types of seedlings were obtained, one type with thick canes having $2n = 118$ chromosomes and the other with thin canes having $2n = 86$ chromosomes. Subramanium[4] has recorded in *Co.* 421, besides normal meiosis, abnormal features in some of the egg mother cells. In these cells the bivalents were found in two groups at the first metaphase, one at the equatorial region with 43 bivalents and the other with 16 bivalents towards the micropylar end. The formation of gametes with 86 chromosomes was inferred to be either from the union of the two nuclei derived from the cell of the dyad with $n = 43$ chromosomes, or by the union of the divided nucleus of the egg cell.

Table 1

Parentage		No. of hybrid seedlings examined	Chromosome number of parents		Chromosome number of hybrids	Chromosome number of gametes functioning	Nature of female gamete functioning
Female	Male		Female $n=$	Male $n=$	$2n=$		
Saccharum officinarum Kaluthai Boothan	*S. spontaneum*	6	40	32	112	(40+40) × 32	Unreduced only
"	" (Coimbatore form)	6	40	32	112	(40+40) × 32	"
Chittan	"	6	40	32	112	(40+40) × 32	"
Lakhapur	"	1	40	32	112	(40+40) × 32	"
Vellai	"	6	40	32	112	(40+40) × 32	"
D.74	"	5	40	15	55	40 × 15	Reduced and unreduced
S. officinarum Vellai	*Sclerostachya fusca*	1	40	15	95	(40+40) × 15	Reduced and unreduced
" "	"	16	53	15	68	53 × 15	Reduced only
Commercial cane *POJ* 2725 (complex of *officinarum* × *spontaneum*)	"						

Table 2

Derivation of the hybrids	No. of hybrids examined	Chromosome numbers of			Remarks
		Female parent $n=$	Male parent $n=$	Hybrids $2n=$	
Co. 421 selfed	3	59	—	86	Parthenogenetic
Co. 421 × *Coix lachryma-jobi*	2	59	10	86	"
Co. 421 × *Bambusa arundinacea*	3	59	35	86	"
Co. 421 × *S. officinarum* (Poovan)	1	59	40	126	
S. officinarum (Vellai) × *Sclerostachya fusca*	1	40	15	60	
S. officinarum (*D.74*) × *S. spontaneum*	1	40	32	60	
POJ 2725 selfed	2	53	—	96	Parthenogenetic

On a re-examination of the slide in 1947, it was noticed that the two groups of bivalents referred to above were clearly in two different spindles (Fig. 1). Fig. 2 shows the polar view of another cell showing two different metaphase plates in the same cell. It is evident that during the first metaphase two spindles are organized in the same egg mother cell, with the result that two metaphase plates with 43 and 16 bivalents are formed. That only the bigger group with 43 bivalents afterwards takes part in the formation of the egg and therefore in fertilization is inferred from the study of the chromosome numbers of the hybrids (Table 2). Although the fate of the smaller group of chromosomes could not be traced further, it is evident that they do not take part in the formation of gametes and that they are eliminated as a group. The formation of gametes with 86 chromosomes can, therefore, be explained as the result of two processes. First, the elimination of 16 bivalents by the formation of two spindles in metaphase 1, and secondly the cell with 43 chromosomes undergoing endomitosis as seen by Bremer[1]. Instances of chromosome elimination through spindle abnormalities have been recorded before in *Ribes nigrum*[5] and in *Eruca sativa*[6].

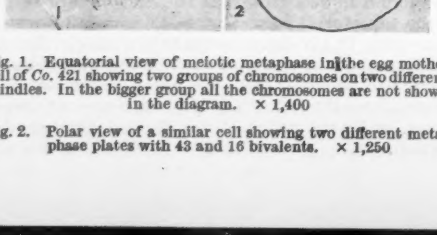

Fig. 1. Equatorial view of meiotic metaphase in the egg mother cell of *Co.* 421 showing two groups of chromosomes on two different spindles. In the bigger group all the chromosomes are not shown in the diagram. × 1,400

Fig. 2. Polar view of a similar cell showing two different metaphase plates with 43 and 16 bivalents. × 1,250

Considered from the evolutionary point of view, such chromosome eliminations *en bloc* in polyploids are very significant. They establish the reversible nature of polyploidy. Hitherto, reversal of polyploidy has been known to be due to parthenogenesis. Elimination of chromosomes has been confined to one or two chromosomes only; elimination of chromosomes *en bloc* has been rare. It is possible that this specialized mechanism, which facilitates such chromosomal eliminations, prevails in *Saccharum* because of its high polyploidy. This high polyploidy not only allows the loss of groups of chromosomes, a loss that would be of serious consequence in a diploid, but also provides for evolutionary changes by such special genetic devices; for this reduction releases and exposes to selection new chromosomal races exhibiting a high range of variability. It is also interesting to note that the reduction of chromosome numbers is followed by an increase of the same through endomitosis. Hence, there are two opposing tendencies in operation, yet leading to a genetic balance; for after the elimination, the egg gametes with 43 chromosomes do not function always as such, but undergo a process of endomitosis. This device leads to the fertility of the progeny. The elimination of chromosomes noted in the cane *Co.* 421, therefore, gives us an idea of the evolutionary steps that are in operation in the complex genus *Saccharum*. It also provides an explanation for the existence of different chromosomal races as in the north Indian sugar-canes[7].

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The Cement Block, an Improved Block for Spore-formation in Yeast

THE gypsum blocks generally used for the production of yeast spores[1] often become infected, on repeated use, with spore-forming bacteria, since they will not tolerate the strong heating necessary for adequate sterilization. We have attempted to prepare a block which can stand such sterilization. After trials with various materials, we finally chose a block cast of Portland cement and kieselguhr, which after hardening in carbon dioxide is sufficiently porous.

The procedure is as follows: 2 parts by weight of kieselguhr and 3 parts of super-rapid Portland cement are mixed carefully; 7–8 parts of water are then added until the mixture is of a plastic consistency. This mixture is poured as a layer about 2 cm. thick into moulds consisting of a cardboard ring placed on a glass plate covered with thin 'Cellophane'. The filled moulds are put in a carbon dioxide atmosphere to harden, for example, in an autoclave. Hardening for three to four days is sufficient, although the blocks appear to be stronger after hardening for a longer period. The blocks are then rinsed in running water for four to eight days until alkali is no longer present.

The blocks can be hardened in air instead of in carbon dioxide. This makes the blocks much stronger; but on account of poor porosity they are not so useful for the present purpose.

The cement blocks may be sterilized by autoclaving at 121° C. for an hour, followed by drying in a hot oven at 80–90° C. for some hours until half-dry. The cooling of the blocks must be carried out slowly as they crack easily on sudden changes in temperature.

The cement blocks are seeded in the same way as gypsum blocks and cleaned by washing under the tap and possibly rinsing for a few hours in running water.

SPORE-FORMATION IN YEAST FOAM AFTER 48 HR. (MEAN OF 6 BLOCKS)

	Vegetative cells	1-spored	2-spored	3-spored	4-spored asci
Cement blocks	44	1	22	25	8 per cent
Gypsum blocks	55	0	19	22	4 „ „

We have used yeast foam (*Saccharomyces cerevisiæ*) to test spore-formation on the various blocks which we have investigated. This yeast gives (see table) somewhat better spore-formation on cement blocks than on gypsum blocks; the number of 4-spored asci especially is increased. Other types of yeast which we have tested have also given better spore-formation on cement blocks.

A more detailed account of this work will appear in *Compt. rend. Lab. Carlsberg*, Sér. physiol.

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Source of 'Serotonin' in Serum

RAPPORT *et al.*[1] prepared from beef serum a vasoconstrictor substance which was called 'serotonin'. By following the pharmacological activity through various stages from serum itself to the final product, it was considered that the substance finally isolated is, in fact, that responsible for the well-known vasoconstrictor activity of serum. The latter substance, which elsewhere[2] has been called 'thrombocytin', depends on the presence of platelets in plasma at the time of clotting[3,4]. For this reason we have repeated Rapport's procedure, applying it to serum prepared from highly centrifuged plasma, on one hand, and to serum prepared from platelet-rich plasma, on the other.

Blood was collected from cattle at the abattoirs into silicone-coated vessels, using sodium citrate as an anticoagulant. It was spun lightly in a Jouan centrifuge (500 *g* at tip, 340 *g* at surface) to throw down the bulk of the red and some of the white cells; the plasma was removed, pooled and respun in a refrigerated international centrifuge (Conical Head No. 845; 650 *g* at tip). The resultant plasma ('platelet-rich' plasma) was opalescent, and microscopic examination showed that its cellular content was mainly platelets. A portion of this plasma was spun a third time (2,000 *g* at tip) to throw down the platelets and obtain a clear ('platelet-free') plasma. The sediment from the third centrifugation was added to the platelet-rich plasma. By these procedures two plasmas were obtained from the same sample of blood, one clear and cell-free, the other opalescent and rich in platelets. Each was clotted by the addition of calcium chloride, and the sera so obtained (1–2 litres in volume) were extracted in parallel in five stages[1], obtaining as the final product a nitro-barbiturate complex for testing on the isolated carotid artery ring of sheep, dog or ox.

The results were clear-cut. Active preparations were obtained in every case (seven) in which the original serum was made from whole blood or platelet-rich plasma. The average yield from 23 litres of serum was 270 mgm./litre, with losses ranging from 52 to 80 per cent. Isolated arterial rings in 10-ml. baths responded to 50 μgm. or more. (Probably less than 1 per cent of the complex is active substance[1].) On the other hand, serum from 'platelet-free' plasma yielded preparations which were almost devoid of activity, whereas serum from the corresponding 'platelet-rich' plasma yielded preparations sixteen or more times as active. A similar ratio between the activity of such paired preparations was also seen in their stimulating actions on the isolated guinea pig gut or rat uterus, in their ability to liberate adrenaline from the suprarenal gland of the cat, and in their ability when injected into the carotid artery of the cat to cause contraction of the nictitating membrane or miosis.

Serum made by clotting platelet-free plasma to which an equal volume of red cells had been added was inactive.

These results show that the appearance of Rapport's serotonin in serum depends on the presence of the lighter elements of the blood (probably platelets) at the time of clotting. They also suggest that the pharmacological actions of serum, on the test objects referred to above, are due to one and the same substance.

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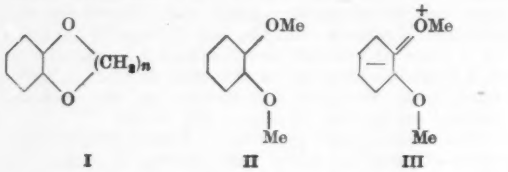
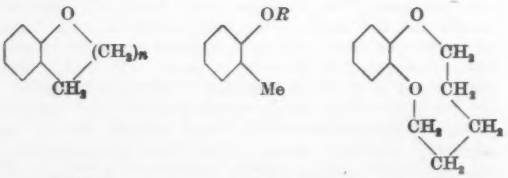
A Novel Connexion between Electrostatic Interaction and Intramolecular Configuration

More than a year ago, we reported that the catechol derivatives (I) were being investigated in the laboratories with the object of increasing our knowledge of the relationship between chemical reactivity and intramolecular configuration[1]. At that time we knew that 3 : 7-dioxa-1 : 2-benz*cyclo*heptene (I, $n = 3$) brominates less readily in glacial acetic acid than do 1 : 3-dioxaindan and 1 : 4-dioxatetralin (I, $n = 1$ and 2 respectively)[2]. This difference in reactivity has also been observed in their rates of hydrogen exchange[3] and is a consequence of the puckered configuration of the seven-membered ring when $n = 3$; the O—CH_2 bonds are oriented out of the plane of the benzene ring and electromeric interaction between this ring and the oxygen atoms is partially inhibited. We expected this interaction to be a maximum in the essentially planar molecules of (I) ($n = 1$ and 2 respectively)[4] and were surprised to find that both these substances are less reactive in the bromination and hydrogen-exchange reactions than is veratrole (II)[1,2].





We assumed that this anomaly was due to direct electrostatic interaction between the two oxygen atoms; we argued that the electric potential of the oxonium ion obtained by electromeric release of electrons from one of the oxygen atoms might be related to the orientation of the neighbouring ether group. The potential should be a minimum when the unshared electrons of this ether group are directed towards the positive charge as in (III), and a maximum when they face in the opposite direction. Thus we considered (II), in which the lower ether group is described as 'facing' the other, to be the configuration which provides ready electrophilic substitution in veratrole, and related the comparatively low reactivities of (I) ($n = 1$ and 2 respectively) to the fact that their ether groups face outwards[5].

We have substantiated this argument in the following two ways: (*a*) Should the anomalously slow bromination of (I) ($n = 1$ and 2) be due to electrostatic interaction between the oxygen atoms, coumaran and chroman (IV, $n = 1$ and 2 respectively) should behave normally. In fact, they are more readily brominated than are the methyl and ethyl ethers of *o*-cresol (V, R = Me and Et respectively), and in this their behaviour is consistent with the enforced planarity of their molecular structures. (*b*) When the heterocyclic ring in (I) includes a sufficiently large number of methylene groups to enable one of the ether groups to face the other, the latter should direct ready electrophilic substitution. We have observed that 3 : 9-dioxa-1 : 2-benz*cyclo*nonene (VI) is brominated even more readily than veratrole[2]. The pertinent data are assembled in the accompanying table.

Relative Rates of Substitution

	Bromination	Hydrogen exchange		Bromination	Hydrogen exchange
Anisole	1	1	V, R = Me	8	1·5
II	4	3	V, R = Et	16	—
I, $n = 1$	0·2	2	IV, $n = 1$	53	—
I, $n = 2$	0·2	1	IV, $n = 2$	28	—
I, $n = 3$	0·09	0·3			
I, $n = 4$	—	1·5			
I, $n = 5$	16				

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Crystal Structure of 'Quinaldil'

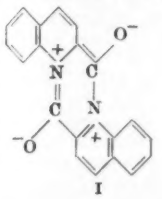
The substance of empirical formula $C_{20}H_{12}O_2N_2$ prepared by Brown and Hammick[1] by the action of potassium cyanide on quinoline-2-aldehyde, or by the decarboxylation of picolinic or quinaldinic acid in quinoline-2-aldehyde, has been found[2] to be identical with that obtained by Buehler and Harris[3].

A sample of Brown and Hammick's material crystallized from pyridine in forms illustrated in the photomicrograph. They belong to the orthorhombic system, and their characteristic consistent face development with dissimilar terminations shows that they are of the crystal class *mm*.

Fig. 1. The crystals in outline resemble a kite or wedge which has its longer axis parallel to the 5·24-A. cell edge, that is, the polar axis *c*. × 30

Examination of the crystals by X-ray methods with copper $K\alpha$-radiation gave the unit-cell dimensions $a = 24{\cdot}8$, $b = 22{\cdot}5$, $c = 5{\cdot}24$ A. This cell contains eight molecules. The absent spectra indicate the space group *Fdd*, a result consistent with the crystal class derived from morphology.

In the space group *Fdd* the general point position *xyz* has 16-fold multiplicity, and the eight molecules must therefore lie on 2-fold symmetry axes in the only special position, repeating at 00*z* and its seven equivalents. The molecule, therefore, itself has a 2-fold axis which coincides with a crystal symmetry axis parallel to *c*, along which the repeat distance is only 5·24 A. The suggested planar molecule I, which has the symmetry axis perpendicular to its plane, would therefore have to lie in a plane at right angles to the short *c*-spacing. However, trial shows that flat



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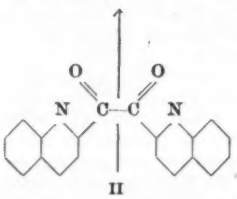

II

molecules of this kind cannot be fitted into the available space. Further, a structure consisting of such molecules in parallel array would have strong negative birefringence with the smallest refractive index parallel to the short axis; but the crystals do not behave in this way. The refractive index for vibrations parallel to the length of the wedge is slightly greater than that for vibrations across the wedge. Form I should be planar; but in attempts to overcome these difficulties it was modified by tilting the quinoline parts out of the plane so as to produce a V-shaped molecule. Fourier syntheses based on the atomic positions for such distorted molecules did not develop the structure. Calculated structure factors did not agree with observed, and what partial indication of atomic positions was given arose from the placing of the quinoline ring systems approximately in the positions which they were later found to occupy.

The form (II), however, leads to the solution of the structure illustrated in the electron density map (Fig. 2). This is an approximation only and is in process of refinement; but it clearly shows all atoms of the molecule separately resolved. The molecule, which is not planar, has a form only roughly indicated by (II). It is non-centrosymmetric and highly polar in the direction of the two-fold axis denoted by the arrow. The arrangement of such molecules, all pointing in the same direction, accounts for the polar character of the crystal, and the fairly steep inclinations of the planes of the aromatic ring systems to (001) are in agreement with the observed optical behaviour.

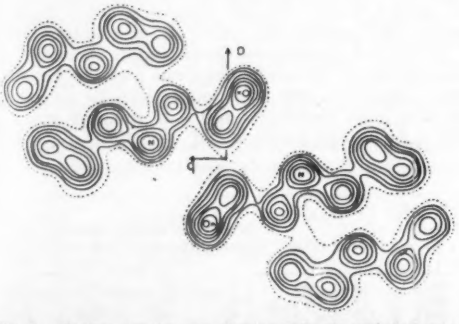

Fig. 2. Electron density map showing molecule projected on a plane perpendicular to the two-fold symmetry axis. Nitrogen (N) and oxygen (Ox) peaks are shown by lettering. All other peaks represent C or CH. The two central carbon atoms are in the plane of projection. Their bonds to the quinoline system slope down from the plane, and those to oxygen are directed above it

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Activity of the Chromium–Aluminium Oxide Catalyst System in the Nitrile–Diene and *n*-Heptane Cyclizations

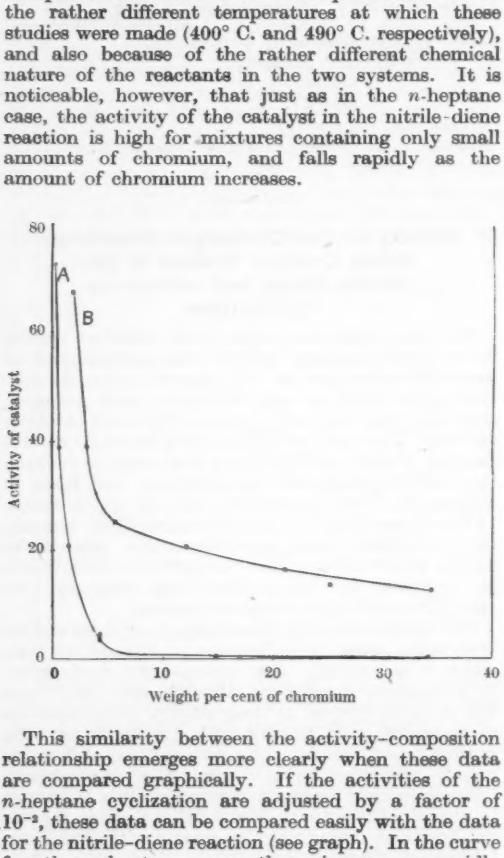
The chromium–aluminium oxide catalyst system is one most commonly used in the aromatization of paraffinic hydrocarbons. In practice, mixtures containing up to 20 per cent chromium oxide are used, this being regarded as the region of greatest catalytic activity. The work of Eischens and Selwood[1] on this catalyst system established the close relation between the activity, magnetic susceptibility, and state of dispersion of the chromium oxide on the alumina. It was shown that at low chromium oxide content, the chromium oxide aggregates into clusters or islands which build up into two and even three layers in thickness, and which have high magnetic susceptibility and high catalytic activity.

The catalyst activity measurements in these studies were made using the *n*-heptane to toluene reaction, which is an example of a 'one-reactant' cyclization–dehydrogenation reaction. Hawkins and Janz[2] used this catalyst system in their studies of the reaction of simple organic nitriles with 1,3-dienes to form pyridinic compounds. This nitrile–diene cyclization may be considered as an example of a 'two-reactant' cyclization–dehydrogenation reaction. It is of interest to compare the activity–composition relation for this catalyst in the more complex system with that found for the one-reactant case.

Composition and Activity of the Chromium–Aluminium Oxide Catalyst System in (*A*) the Nitrile–Diene Cyclization, and (*B*) the *n*-Heptane Cyclization:
(*A*) Benzonitrile + Butadiene = 2-Phenylpyridine + H_2.
(*B*) *n*-Heptane = Toluene + $3H_2$.

Catalyst	Activity of catalyst	
Wt. per cent of chromium	Space–time–yield of 2-phenylpyridine (mol. × 10^4/hr./gm. chromium)	Space–time–yield of toluene (mol. × 10^3/hr./gm. chromium)
0·34	72·5	
0·68	39·2	
1·54	20·8	
1·9		67·9
3·2		39·3
4·38	3·45, 4·33, 4·50, 3·96	
5·7		25·4
12·2		20·8
15·4	0·10, 0·07	
21·1		16·5
27·2		13·7
34·2	0·38, 0·10	12·6

A comparison of the activity–composition relation in these two reactions is possible if the results are calculated as activities per unit weight of chromium in the mixed catalysts in each case. For this purpose the results in the nitrile–diene and *n*-heptane reactions have been recalculated in terms of space–time–yield of product per gram chromium. These results are summarized in the accompanying table. A comparison shows that the activities are significantly lower throughout in the nitrile-diene case than in the *n*-heptane case. This is not unexpected in view of the rather different temperatures at which these studies were made (400° C. and 490° C. respectively), and also because of the rather different chemical nature of the reactants in the two systems. It is noticeable, however, that just as in the *n*-heptane case, the activity of the catalyst in the nitrile-diene reaction is high for mixtures containing only small amounts of chromium, and falls rapidly as the amount of chromium increases.



This similarity between the activity–composition relationship emerges more clearly when these data are compared graphically. If the activities of the *n*-heptane cyclization are adjusted by a factor of 10^{-2}, these data can be compared easily with the data for the nitrile–diene reaction (see graph). In the curve for the *n*-heptane case, there is seen a rapidly decreasing activity with increasing percentage chromium in the catalyst, and a noticeable change of slope at about 6 per cent chromium. This 'point' of change of slope and change in activity was shown by Eischens and Selwood to be closely related to similar changes in the magnetic susceptibility of the chromium in this catalyst system. For the nitrile–diene cyclization, the activity–composition relation is strikingly similar. There is the same rapid decrease in the activity with increasing chromium content, and 'point' of change of slope occurs also at approximately 6 per cent chromium. The curve seems to be essentially the same in type as found for the *n*-heptane to toluene reaction.

Hence, the activity–composition relation of the chromium–aluminium oxide catalyst system found in the more complex case of a cyclization–dehydrogenation reaction involving two reactants is quite similar to that observed in the simple case involving only one reactant.

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Relationship between Base Saturation and Crop Response to Phosphate in Acid Soils

In an attempt to relate phosphate responses in the field with soil analyses, the most significant correlations I have yet obtained have been between response and the percentage saturation of the base exchange capacity. It should be noted that all the soils, with one exception, lay within the range *p*H 4·7–6·3. In three groups of experiments (fifty-six observations) on wheat, grass and millet, the regressions of crop response (percentage increase in yield due to superphosphate over control) on the percentage saturation of the base exchange capacity were highly significant ($P < 0.01$) in spite of the fairly wide variation in soil types. The relationship was an inverse one, and the equations indicated that phosphate responses are not to be expected when base saturation exceeds about 80 per cent. A similar relationship was found between response and exchangeable calcium expressed as a percentage of exchangeable calcium plus exchangeable hydrogen, that is, in units similar to the percentage saturation of the base-exchange capacity.

These results indicate that the percentage saturation of the base exchange capacity (or exchangeable calcium expressed as above) are, in acid soils, a measure of the availability of the soil phosphate. Additional support for this is given by the fact that the control yields were significantly and directly related to the percentage saturation of the base exchange capacity, while the phosphate response was significantly and inversely related to the control yield. On the other hand, the amounts of acid-soluble phosphate (Truog's method and phosphate soluble in 0·1 *N* hydrochloric acid), adsorbed phosphate (extractable with 0·5 *N* neutral ammonium fluoride) and water-soluble phosphate (Burd's method)[1] showed no such conclusive correlations with response or control yield. Typical results, selected from the grass experiments (see Table 1), are illustrative.

A few discrepancies were found between the magnitude of phosphate response and the degree of base saturation, but these could well be referred to adverse field conditions and the different effects of the soils on the efficiency of the added phosphate.

Table 1

Soil No.	p.p.m. P_2O_5 Ads.	Acid sol.	Water sol.	Per cent sat. base exchange capacity	Per cent resp.	Control yield (tons/acre)
6708	29	49	4·3	44	50	0·7
6621	18	10	4·1	54	21	1·6
6577	27	5	1·3	60	15	2·7
6025	27	22	5·0	64	12	1·8
6633	16	48	1·2	68	9	1·9
6585	24	8	2·5	74	6	3·1
6645	134	155	9·4	81	−2	3·8

Table 2

Per cent saturation of the base exchange capacity	Average percentage response to phosphate		
	Wheat	Grass	Millet
60 and below	111	26	125
61 to 70	44	11	27
71 and above	21	4	5

On the whole, however, the dependence of response on base saturation was well defined, as shown in Table 2.

There is considerable evidence in the literature that exchangeable bases, notably calcium, can retain appreciable amounts of phosphorus in a readily accessible form for plant use. Allison[2] found evidence of such retention as a $H_2PO_4^-$ – Ca – micelle linkage over the *p*H range 4·0–6·0, which approximates closely to that for the soils in these experiments. Such phosphate may be considered as saloid-bound, that is, existing as ions in the diffusible ionic atmosphere outside the soil micelle. Saloid-bound phosphate can undergo secondary reactions in the soil to the less available colloid-bound form which is directly associated with the micelle and is non-diffusible.

Such transformations have been reported by Barbier and Chabannes[3], while Ravikovitch[4] has demonstrated that as the degree of base saturation decreases, the proportion of colloid-bound to saloid-bound phosphate increases. A high degree of base saturation in acid soils implies, therefore, that conditions are favourable to the retention of part at least of the soil phosphate, in the available saloid-bound form. With decreasing saturation there is an increasing probability of the soil phosphate existing in the less available colloid-bound form. The percentage saturation of the base exchange capacity is, therefore, directly related to phosphate availability and inversely to phosphate response.

In acid soils a study of base-saturation data offers a logical approach to the problem of relating chemical tests with phosphate response and availability. In conventional methods a number of forms of phosphate of different degrees of availability are usually measured, or secondary reactions may take place during the extraction procedure, making the resultant value in either case difficult to interpret. In contrast, the percentage saturation of the base exchange capacity refers to the conditions governing the existence of a single form of available phosphate. It is more important to know whether available phosphate is likely to be present than the amount of some form arbitrarily, but often incorrectly, assumed to be available. I have not yet attempted to measure the amount of saloid-bound phosphate present because it is doubtful if, in fact, such a procedure is necessary. All the soils so far investigated appear to have an adequate amount of native soil phosphate for satisfactory plant growth, provided only that the degree of base saturation is sufficiently high.

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Determination of Sodium Gentisate by Chromatography and Fluorescence

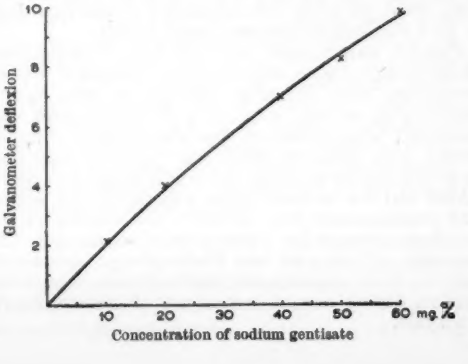
The determination of sodium gentisate (2 – 5 dihydroxybenzoate) in urine is important because of the use of gentisate as a therapeutic in rheumatic fever, and the presence of sodium gentisate in urine after administration of sodium salicylate[1].

We have devised a quantitative method for the determination of gentisate in urine. Portions of 10 c.mm. of the urines are placed on Whatman No. 1 filter paper at a distance of 5 cm. from the edge of the paper; also some spots of known gentisate concentrations are applied. A chromatogram is developed using the ascending technique[2] with the upper layer given by a mixture of two parts of benzene, two parts of glacial acetic acid, one part of water (cf. ref. 3). After 18 hr. at room temperature under an air-tight cover the paper is dried in the air. The gentisic acid is now made visible by its strong blue fluorescence in ultra-violet light, using a Philips *HPW* lamp, which emits the wave-length 3655 A. The R_F value of gentisic acid in these conditions is 0·1–0·2. For quantitative determination it is necessary to be sure that the ultra-violet intensity is the same for each spot.

The fluorescent spots are measured with a selenium cell (diameter 1 cm.). The cell is placed under a piece of lead glass 5 mm. thick (the same glass as used in X-ray screens). Above the cell, which is mounted in a wooden frame, a zinc plate is mounted with a circular diaphragm above the cell and of the same size as the cell. The ultra-violet lamp is mounted in a frame about 17 cm. above the plate and perpendicularly above the diaphragm. The strip of paper with the spots is cut out (perpendicular to the direction of development) and is drawn between the plate and the wooden frame, so that each spot passes under the diaphragm. The lead glass does not transmit the ultra-violet, as is seen by the absence of fluorescence behind the glass.

The largest spot must be smaller than the area of the diaphragm. The deviation of the galvanometer plotted against the concentration of known solutions of pure gentisic acid treated in this way proved to be nearly a straight line (below 60 mgm. per cent) (see graph). This line passes through the origin if the blank given by the paper under the ultra-violet lamp is taken as the zero point. This blank value is due to transmission of a little violet light.

At higher concentrations than about 60 mgm. per cent a photocell of at least 2 cm. diameter should be used, as the (elliptical) areas of the fluorescent spots become otherwise larger than the photocell area.



We believe that with such photocells the linearity should be valid up to higher concentrations; the accuracy is about 1 mgm. per cent.

By dissolving gentisate in normal urines it was found that this method of determination of gentisate is not disturbed by other substances present in urine.

Confusion with substances such as salicylic acid and salicyluric acid is impossible because they move faster in the chromatogram (R_F + 1·0 and 0·3–0·4). Furthermore, the gentisic acid is characterized by its strong blue fluorescence, and by the fact that standard concentrations of gentisate are always chromatographed on the same paper.

For urine this method is more specific than colour reactions with phenol reagents[4,5], especially when salicylic acid is also present.

The present method is a simplification of a more complicated method, which was used formerly in our Laboratory[1]. With this method it was found by Winkel[1] that up to 30 per cent of a given dose of salicylate is recovered in the urine as the gentisate in rheumatic fever.

The accuracy at low concentrations can be increased by applying more than one quantity of 10 c.mm. to the chromatogram paper.

The method may be useful for determination of other fluorescent substances.

Our thanks are due to Prof. E. Gorter for his interest in the development of this method of determination.

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Destruction of Dinitrophenyl Amino-Acids by Tryptophane

The only dinitrophenyl amino-acids revealed by paper chromatography[1] and the use of silica columns[2] during an attempt to identify and estimate the free amino groups of lysozyme by the method of Sanger[3] were ε-dinitrophenyl-lysine and *bis*-dinitrophenyl-lysine. The recovery of the former from hydrolysed dinitrophenyl-lysozyme, using silica columns, suggested that lysozyme contains five non-terminal lysine residues; but the amount of *bis*-dinitrophenyl-lysine recovered was only one-third of that to be expected from one N-terminal amino-group. Similar results were obtained when lysozyme was first treated with urea[2], or when the conditions of reaction with 1 : 2 : 4-fluorodinitrobenzene were varied.

Control experiments showed that whereas *bis*-dinitrophenyl-lysine alone could be recovered almost completely after refluxing with 20 per cent hydrochloric acid for six hours, only 60–76 per cent was recovered when lysozyme was also present. Similar values were obtained when the lysozyme was first hydrolysed for six hours, the *bis*-dinitrophenyl-lysine added and the mixture again refluxed for six hours. The intact protein was therefore not responsible for the destruction of the dinitrophenyl amino-acid. The amounts of lysozyme and dinitrophenyl amino-acid used in these experiments were equivalent to those present during normal hydrolysis of dinitrophenyl-lysozyme.

The original tests of Porter and Sanger[4] for the recovery of dinitrophenyl amino-acids were carried out in the presence of globin. A striking difference between globin and lysozyme is the relatively large amount of tryptophane (10·6 per cent)[5] in the latter protein. It was found that refluxing *bis*-dinitrophenyl-lysine in the presence of tryptophane gave low recoveries of the same order as those obtained in the presence of an equivalent amount of lysozyme. On the other hand, the dinitrophenyl amino-acid could be recovered almost completely (Table 1) after refluxing with other representative amino-acids (alanine, arginine, serine, tyrosine and aspartic acid).

Table 1. Recovery of *bis*-Dinitrophenyl-lysine
(1·28 mgm. dinitrophenyl amino-acid; 6 hours refluxing with 5 ml. 20 per cent hydrochloric acid)

Substance	Amount added (mgm.)	Per cent recovery
—	—	97
Lysozyme	40	68
Tryptophane	4·4	73
Alanine	2·9	96
Arginine hydrochloride	6·85	96
Aspartic acid	8·23	93
Serine	3·23	95
Tyrosine	3·8	94

The amounts of amino-acids were equivalent to 40 mgm. lysozyme except in case of tyrosine

The rate at which *bis*-dinitrophenyl-lysine (1·28 mgm.) is destroyed when refluxed with tryptophane (4·4 mgm.) is shown in Fig. 1 and the effect of increasing the amount of tryptophane in Fig. 2. It will be seen that with sufficient tryptophane the destruction of the dinitrophenyl amino-acid is nearly complete in 24 hr.

Control experiments showed that the loss of *bis*-dinitrophenyl-lysine is not due to adsorption on the humin formed from tryptophane during hydrolysis.

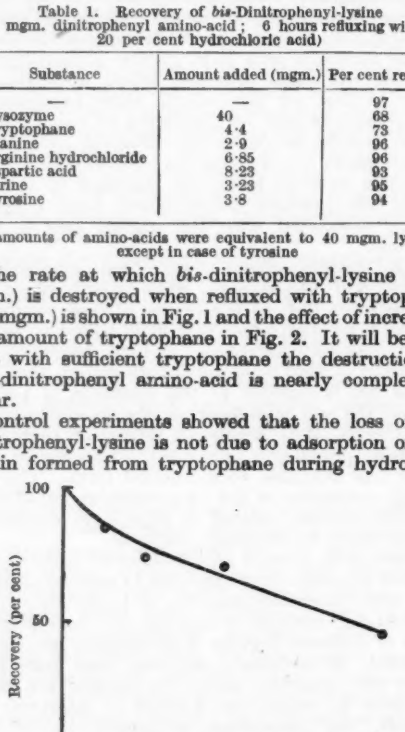

Fig. 1. Rate of destruction of *bis*-dinitrophenyl-lysine

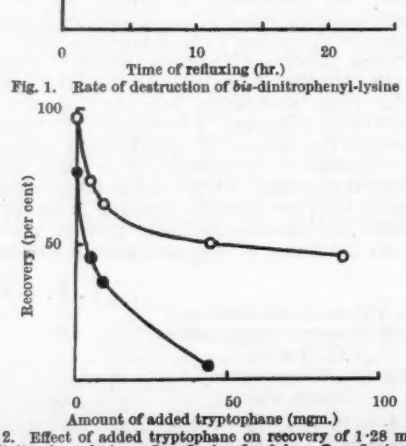

Fig. 2. Effect of added tryptophane on recovery of 1·28 mgm. *bis*-dinitrophenyl-lysine; O, refluxing for 6 hr.; ●, refluxing for 24 hr.

It is almost certainly due to chemical reaction between *bis*-dinitrophenyl-lysine and tryptophane (or breakdown products of tryptophane) and, after removal of the unchanged dinitrophenyl amino-acid by ether extraction, a coloured compound can be extracted from the aqueous solution with butanol. On paper chromatograms run with chloroform-ammonia, this product travels almost with the solvent front and cannot, therefore, be another dinitrophenyl amino-acid; it appears to run faster than 2 : 4-dinitro-aniline.

The presence of tryptophane also led to the destruction of certain amounts of other dinitrophenyl amino-acids (Table 2).

Table 2. Recovery of Dinitrophenyl Amino-Acids in the Presence and Absence of Tryptophane
($2{\cdot}67 \times 10^{-6}$ moles of dinitrophenyl amino-acid; 6 hr. refluxing with 5 ml. 20 per cent hydrochloric acid)

Dinitrophenyl amino-acid	Per cent recovery	
	No tryptophane	4·4 mgm. tryptophane
DNP-alanine	96·5	66
DNP-leucine	100	91
DNP-phenylalanine	99	88·5
DNP-glycine	58	44
DNP-valine	101·5	91

It is clear that quantitative recoveries of dinitrophenyl amino-acids cannot be expected from proteins with a high proportion of tryptophane to the N-terminal amino-acid, especially if a long period of hydrolysis is given. Probably few proteins, however, contain as many as eight residues of tryptophane per polypeptide chain (the number present in lysozyme[4]), so that, in general, the losses would not be so serious as those described above.

Even when allowance was made on the basis of these control experiments for the destruction during hydrolysis of *bis*-dinitrophenyl-lysine, the amount recovered from dinitrophenyl lysozyme corresponded to little more than half the amount expected from one N-terminal lysine residue. This might indicate the inadequacy of these control experiments in assessing the degree of breakdown of the dinitrophenyl amino-acid while in peptide linkage, or the heterogeneity of the protein preparation. Similar results were obtained with crystalline lysozyme prepared by me and that from a commercial source. Electrophoresis of the latter seemed to indicate its purity, though, if the electrophoresis was prolonged, a small second peak appeared.

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Downing Street,
Cambridge. April 27.

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Fermentation of Malt Extract

AN investigation is being carried out on a sample of malt extract which, after standing for some months, was found to have fermented. As the extract contains about 50 per cent of sugars, mostly maltose, any organism capable of ferment must be highly osmophilic.

Various organisms have been isolated from both fresh and fermented samples of malt extract, but of them only certain yeasts were found capable of fermenting the yeast-free malt when pure cultures were inoculated back into it. With one exception, these yeasts have been found to be species of *Zygosaccharomyces*, a genus which contains many osmophilic species capable of fermenting substances such as maple syrup[1], honey[2], and the intermediate products of sugar manufacture[3].

Five of the isolates were sent to the Centraalbureau voor Schimmelcultures at Baarn, Holland, where all were identified as *Z. japonicus* Saito, though they differed slightly in minor cultural characteristics. *Z. japonicus* was originally found by Saito in "products of fermenting Soya"[1], and has since been recorded by Fabian and Hall in maple syrup and by Fabian and Quinet in honey.

That the organism can grow on substrates of considerably higher osmotic pressure than malt extract is shown by its power of fermenting almost saturated solutions of maltose, and glucose solutions of as high a concentration as 90 per cent w/v.

Studies on the biology of the fermentation are continuing.

My thanks are due to Dr. S. W. F. Underhill for his encouragement, and to the Directors of The British Drug Houses, Ltd., for permission to publish this communication.

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Graham Street,
London, N.1. April 27.

[1] Fabian, F. W., and Hall, H. H., *Centralbl. Bakt.*, Abt. II, **39**, 31 (1933).
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Absence of Hydrogen Radiation of Wave-length 21 cm. in the Sun

OBSERVATIONS have been made at the Kootwijk Station of the Dutch Organization for Radio Astronomy, in order to ascertain whether hydrogen radiation of 21 cm. wave-length, detected in the galaxy, would be found also in the sun. The 7·50-metre mirror and the receiver technique were the same as used for the investigations of the Galaxy*. No indication of a spectral line was found. The apparatus was sufficiently sensitive to detect a variation of 1/260 in the continuous radio spectrum.

The line, if present, ought to be an emission line, since the temperature in the corona is decreasing with depth. Collisions would not prevent the emission of the line: for its excitation potential is so very low that half the hydrogen atoms are always on the excited level. Calculation shows that for this wave-length the solar layers are only transparent up to about 9,000 km. above the photosphere; and that in the whole corona and upper chromosphere above this level the number of neutral hydrogen atoms is so small that less than 1/1,000 of the amount necessary for detection is present. The absence of the line is thus entirely understandable.

C. DE JAGER
M. MINNAERT
C. A. MULLER
Dutch Organization for Radio Astronomy,
Kootwijk Radio, Holland. Aug. 1.

* See p. 356 of this issue of *Nature*.

FORTHCOMING EVENTS

Monday, September 3—Saturday, September 8

BRITISH INTERPLANETARY SOCIETY (at Caxton Hall, Westminster, London, S.W.1).—Second International Congress on "Astronautics".

Tuesday, September 4—Thursday, September 6

BRITISH INSTITUTION OF RADIO ENGINEERS (at Earls Court, London, S.W.5).—Radio Conference, Session 6: "Audio Frequency Engineering".

Sunday, September 9—Friday, September 14

INTERNATIONAL UNION OF LEATHER CHEMISTS' SOCIETIES (in the Portland Hall Annexe, Regent Street Polytechnic, Little Titchfield Street, London, W.1).—Second International Conference.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER (biophysicist or physicist with experience of radioactive isotopes) IN THE DEPARTMENT OF SURGERY—The Secretary, The University, Edinburgh (September 8).

ASSISTANT IN EXPERIMENTAL PHYSICS—The Secretary, The University, Aberdeen (September 10).

ASSISTANT LECTURER IN APPLIED OPTICS, and an ASSISTANT LECTURER IN CHEMICAL ENGINEERING—The Registrar, College of Technology, Manchester 1 (September 10).

ASSISTANT LECTURER IN CHEMICAL ENGINEERING—The Registrar, The University, Leeds 2 (September 10).

LECTURER, and an ASSISTANT LECTURER, IN THE DEPARTMENT OF CHEMISTRY—The Clerk, Birkbeck College, Breams Buildings, London, E.C.4 (September 10).

PHYSICAL CHEMIST or BIOCHEMIST (with a good honours degree or its equivalent in chemistry with either a special interest in physical chemistry or experience in spectroscopy) in the Chemistry Division, Soil Bureau, Wellington, to develop techniques of spectroscopic analysis for a minor element survey of New Zealand soil types—The High Commissioner for New Zealand, 415 Strand, London, W.C.2, quoting A/B.3/64/85 (September 10).

SENIOR EXPERIMENTAL OFFICER (with pass degree, or equivalent, in engineering, agriculture or natural science, and with previous experience of work of a similar nature) to take charge of an information unit comprising library, abstracts, publications and a small film and photographic studio—The Secretary, National Institute of Agricultural Engineering, Wrest Park, Silsoe, Beds (September 10).

SENIOR LECTURER IN ELECTRICAL ENGINEERING—The Secretary, South-East London Technical College, Lewisham Way, London, S.E.4 (September 10).

RESEARCH ASSISTANT (graduate in geography) IN THE DEPARTMENT OF GEOGRAPHY, to undertake an investigation within the field of Economic Geography on 'The Journey to Work on Merseyside'—The Registrar, The University, Liverpool (September 12).

ASSISTANT CIVIL ENGINEER, and an ASSISTANT MECHANICAL ENGINEER, in connexion with the design, maintenance and construction of dock and harbour works—The Secretary, Tyne Improvement Commission, Bewick Street, Newcastle-upon-Tyne 1 (September 15).

CHIEF EXAMINER IN HYGIENE—The Registrar, University Office, 46 North Bailey, Durham (September 15).

CURATOR IN GEOLOGY—The Director, City Museum, Bristol 8 (September 15).

LECTURER to teach PHYSICS to degree standard, and an ASSISTANT (Grade A) to teach ELEMENTARY PHYSICS up to the standard of the General Certificate of Education (Advanced level)—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (September 15).

CHIEF COAL SURVEY OFFICER at the Coal Survey Laboratory in Birmingham—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/367 (September 22).

PHYSICISTS or MATHEMATICAL PHYSICISTS, PHYSICISTS, MATHEMATICIANS or ENGINEERS, at the Royal Aircraft Establishment, Farnborough: (Ref. A.133/51A/BD) PRINCIPAL SCIENTIFIC OFFICER with experience of radar systems analysis and war-time operational research; a strong mathematical bias is desirable, (Ref. A.134/51A/BD) SENIOR SCIENTIFIC OFFICER for theoretical investigations; a knowledge of statistical methods is desirable, (Ref. C.217/51A/BD) SENIOR SCIENTIFIC OFFICER with experience in planning and analysis of flight trials and application of results to project design; a knowledge of servo mechanism theory and practice is required, (Ref. A.135/51A/BD) SENIOR SCIENTIFIC OFFICER with research experience involving arithmetical applications of mathematics in the analysis of physical data and the formulation of problems for solution by automatic computing machinery, (Ref. A.136/51A/BD) SENIOR SCIENTIFIC OFFICER with wide experience of methods of measurement in physics or engineering research, experience and up-to-date knowledge of electronics—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (September 22).

SPECIALIST TECHNICAL EDITOR (with honours degree in mathematics and/or physics, or in mechanical engineering; experience of teaching, writing or editing of textbooks on such subjects, etc.) at a Ministry of Supply establishment at Chessington—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.243/51A (September 22).

LECTURER IN GAS CHEMISTRY—The Registrar, The University, Leeds 2 (September 26).

CHEMISTS and METALLURGISTS (Experimental Officer grade) at a Ministry of Supply research establishment in Berkshire: METALLURGIST (Ref. F.591/51A) with research experience in electrodeposition or in the investigation of the properties of metallic films and coatings, and a PHYSICAL CHEMIST or PHYSICIST (Ref. F.592/51A) with interest and preferably experience in work on ceramic materials—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (September 29).

LECTURER or ASSISTANT LECTURER IN THE DEPARTMENT OF ZOOLOGY, University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (September 29).

TECHNICAL AUTHORS at Ministry of Supply establishments at Chessington, Malvern and Farnborough, for the preparation of official instructional publications on the theoretical and practical (including servicing) aspects of airborne and ground centrimetric radar or radio communications equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.375/51A (September 29).

ENGINEER (Class 3), and an ASSISTANT ENGINEER (Class 1), in the Research Section of the New South Wales Department of Road Transport and Tramways—The Agent General for New South Wales, 56 Strand, London, W.C.2 (October 1).

MECHANICAL ENGINEER, with headquarters in London, to test and report upon various items of mechanical equipment—The Secretary, Forestry Commission, 25 Savile Row, London, W.1 (October 1).

PRINCIPAL SCIENTIFIC OFFICER (with a first- or second-class honours degree in physics and some knowledge of electro-acoustics and electronics, with experience in the planning of research), R.A.F. Acoustics Laboratory—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4063/51 (October 4).

SCIENTIFIC ADVISER (with a first- or second-class honours degree in mathematics or physics, or mathematics and physics) in the Ordnance Survey Department, Chessington, to advise the Director General on all physical and mathematical matters that arise from the various activities of the Ordnance Survey—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4062/51 (October 4).

LECTURER IN METALLURGY in the Department of Mining Engineering, University of Queensland—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 6).

SCIENTIFIC ASSISTANT (with a university degree in electrical or mechanical engineering or physics) IN THE DEPARTMENT OF SCIENCE AND INDUSTRY—The Director, City Museum and Art Gallery, Birmingham 3 (October 15).

DIRECTOR (of highest professional and organizational ability, capable of directing physico-chemical and technological research)—The Secretary, Ahmedabad Textile Industry's Research Association, P.O. Box 170, Ahmedabad, India (October 31).

ABSTRACTORS for the *Veterinary Bulletin* particularly for literature on chemistry, biochemistry, physiology and pharmacology, in French, German, Italian, Spanish and Scandinavian languages—The Director, Commonwealth Bureau of Animal Health, Veterinary Laboratory, New Haw, Weybridge, Surrey.

ADVISER IN AGRICULTURE (Ref. M.27741/A) and an ADVISER IN HORTICULTURE (Ref. M.27742/A) for the Iraq Development Board—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting the appropriate Ref. No.

ASSISTANT IN THE DEPARTMENT OF PHYSICS AND OPTICS at the College of Technology—The Director of Education, 14 Sir Thomas Street, Liverpool 1.

ASSISTANT (female) with honours degree in physiology (zoology considered) in department chiefly concerned with clinical electroencephalography, also E.M.G., E.C.G., etc., with opportunities for human research—The Secretary, National Hospital, Queen Square, London, W.C.1.

ASSISTANT (Scientific) with practical farming experience and experience of handling machines in the field—The Secretary, National Institute of Agricultural Engineering, Wrest Park, Silsoe, Beds.

ASSISTANT LECTURER IN PHYSIOLOGY—Prof. D. S. Torrens, School of Physic, Trinity College, Dublin.

ASSISTANT PHYSICIST to the Leicester Regional Centre for Radiotherapy at the Leicester Royal Infirmary—The Secretary, No. 1 Hospital Management Committee, 38a East Bond Street, Leicester.

CHEMISTS, METALLURGISTS and PHYSICISTS (Scientific Officer grade) at a Ministry of Supply research establishment near London and the Royal Aircraft Establishment, South Farnborough: PHYSICAL METALLURGISTS (Ref. 582/51A) for the determination of thermal and physical properties of metals and alloys, PHYSICAL CHEMIST or PHYSICIST (Ref. F.583/51A) with an interest in metallurgy or ceramics, for research investigations connected with the preparation of novel ceramic materials, and a PHYSICAL CHEMIST or PHYSICIST (Ref. F.584/51A) for work on surface phenomena and for research investigations into the properties of metallic films and coatings—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No.

CIVIL ENGINEERS (Main grade) (Ref. E.251/51) and ASSISTANT CIVIL ENGINEERS (Recruitment grade) (Ref. E.252/51) in the Directorate-General of Works, Air Ministry, in London and the Provinces—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No.

CURATOR IN ANTHROPOLOGY at the Raffles Museum, Singapore—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27456/51 Appts.

DIRECTOR of the Government of Iraq Chemical Laboratory at Baghdad, and an ASSISTANT TO THE DIRECTOR—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.27714.G.

EDUCATIONAL PSYCHOLOGIST for research work in connexion with mental deficiency—The Physician-Superintendent, Royal Eastern Counties' Institution, Abbeygate House, Colchester.